DOCUMENT RESUME

ED 039 147 24 SE 008 605

AUTHOR	Austin, Gilbert R.
TITLE	A Longitudinal Evaluation of Mathematical Computational Abilities of New Hampshire's Eighth Graders: 1963-1967, Final Report.
INSTITUTION	New Hampshire Univ., Durham.
SPONS AGENCY	Office of Education (DHEW), Washington, D.C. Bureau of Research.
BUREAU NO	BR-9-A-023
PUB DATE	15 Aug 69
GRANT	OEG-1-9-090023-0106(010)
NOTE	110p.
EDRS PRICE	EDRS Price MF-$0.50 HC-$5.60
DESCRIPTORS	*Evaluation, Grade 8, Grade 10, *Longitudinal Studies, Mathematics, *Research, *Secondary School Mathematics, *Student Characteristics, Textbook Content

ABSTRACT

The purpose of this study was to evaluate the effects of using different mathematics textbooks on the mathematical computational ability of students as a method of assessing the effectiveness of different mathematics instruction. This study resulted from a 1963 report which discussed the results of the New Hampshire Statewide Eighth Grade Testing Program and the observation that a significant drop in the arithmetic computation scores occurred in 1964 and 1965. A study of the data collected in 1967 involved three different phases. The results of phase one indicated that the introduction of modern mathematics is somewhat responsible for the decline in computational ability. The second phase compared the arithmetic computational ability of 1965 eighth graders with 1967 tenth graders. The results suggested no significant differences in computational ability in grade ten between traditional, transitional, and modern groups. The third phase involved a select group of tenth graders and their abilities in algebra and geometry. The conclusions were that students who had studied either a modern or a transitional textbook did markedly superior work to those who had used only a traditional textbook. (FL)

ED039147

BR 9-A-023
PA 24

OE/BR

SE

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL OFFICE OF EDUCATION POSITION OR POLICY.

FINAL REPORT
Project No. 9-A-023
Grant No. OEG-1-9-090023-0106(010)

A LONGITUDINAL EVALUATION OF MATHEMATICAL COMPUTATIONAL ABILITIES OF NEW HAMPSHIRE'S EIGHTH GRADERS: 1963-1967

Gilbert R. Austin
University of New Hampshire
Durham, New Hampshire 03824

August 15, 1969

U.S. Department of Health,
Education and Welfare

Office of Education

Bureau of Research

SE 008 605

ED0 39147

SUMMARY

A LONGITUDINAL EVALUATION OF MATHEMATICAL COMPUTATIONAL ABILITIES OF NEW HAMPSHIRE'S EIGHTH GRADERS 1963-67

The intent of this study was to assess the impact of the introduction of modern mathematics text books on the computational ability of students in New Hampshire. In 1963 a report discussing the results of the New Hampshire Statewide Eighth Grade Testing Program, written by Dr. Walter N. Durost, indicated the mean raw score in the state of New Hampshire in arithmetic computation was 34 raw score points, and its grade equivalent was 8.8. This was consistent with a pattern that had been established for some years. New Hampshire had always done well in the area of arithmetic computation.

In 1964 the pattern changed markedly. It became apparent that there had been a significant drop in the arithmetic computation scores since 1963. This drop continued into 1965 when the first study authorized by the New Hampshire State Department of Education was conducted by the Bureau of Educational Research and Testing Services. The results of that study clearly indicated, for the three groups designated as modern, traditional, and transitional, that in intellectual skills as measured by the Otis Intelligence Test, the modern group was clearly superior, followed in order by the group classified as being transitional, and the group classified as being traditional. On mathematics computation the exact inverse was true. The traditional group scored highest, followed by the transitional group, followed by the modern group.

The first phase of this study of the 1967 data was a replication of that earlier 1965 study. The results clearly indicate that again the group classified as modern was intellectually superior to the groups classified as traditional or transitional, as measured by the School and College Ability Test. The computation sub-test of the Stanford indicated the modern group performs no better than the transitional group. It needs to be pointed out, however, that the scores obtained by each of these groups on the Stanford Arithmetic Computation sub-test were markedly lower than they were in 1965 and still lower than they were in 1963. In 1963, using the Metropolitan in a fall administration, the grade equivalent was 8.8. In 1967, using the Stanford in a fall administration, the grade equivalent was 6.8. This means that in five years, 1963-1967, there had been a two-year decline in mathematics computation abilities in New Hampshire. It is not possible to conclude from this study that this is a direct result of the kind of text books used, but it is the author's opinion that the introduction of modern mathematics is at least somewhat responsible for the decline in computational ability.

It is believed by the author that even in traditional and transitional schools, so designated by their text books, there has been increasing emphasis on understanding with a corresponding decrease in the time allocated to practice of meaningful drills in arithmetic computation.

A second phase of this study was to compare the performance of community (1965) eighth grade means with community (1967) tenth grade means to make comparisons of arithmetic computational ability between eighth and tenth grade. The findings clearly indicate that although there were differences depending upon the kind of text book used at eighth grade, this is no longer true at tenth grade. There are no significant differences in mathematical computational ability at grade ten between these three groups as measured by the Stanford Numerical Competency sub-test. There are, however, interesting and provocative differences using the Stanford High School Mathematics sub-test, Part A, which measures Algebra and Geometry. We find very real and important differences in students' abilities dependent upon the kind of text book they have been exposed to.

The third phase of this particular study was to take a select subgroup of tenth graders and compare their abilities in the area of Algebra and Geometry, still controlling for the type of text book that they had used in their previous years of school. We find clearly that students who have studied in either a modern or a transitional text book do markedly superior work to those who have studied using only a traditional text book.

Results of these three studies in mathematics computational abilities in the state of New Hampshire would seem to indicate the following: There has been a serious decline in mathematics computational ability at grade eight in the state of New Hampshire. By grade ten this difference is no longer statistically significant. It also becomes apparent that modern mathematics begins to pay its greatest dividends when students are being expected and requested to master the concepts associated with Algebra and Geometry. This, it seems to the author, provides information on which Superintendents, Principals, and curriculum workers in the area of mathematics might make important curriculum decisions. The implications of these studies argue cogently, the author believes, for the use of differentiated text books in school systems.

FINAL REPORT
Project No. 9-A-023
Grant No. OEG-1-9-090023-0106(010)

A Longitudinal Evaluation of Mathematical Computational Abilities of New Hampshire's Eighth Graders: 1963-1967

Gilbert R. Austin
University of New Hampshire
Durham, New Hampshire 03824

August 15, 1969

The research reported herein was performed pursuant to a grant with the Office of Education, U.S. Department of Health, Education and Welfare. Contractors undertaking such projects under Government sponsorship are encouraged to express freely their professional judgment in the conduct of the project. Points of view or opinions stated do not, therefore, necessarily represent official Office of Education position or policy.

U.S. Department of Health,
Education and Welfare

Office of Education

Bureau of Research

Acknowledgement

The evaluation reported herein, under the direction of Gilbert R. Austin, could not have been completed without the cooperation of many other persons.

The author gratefully acknowledges the support and assistance of the following individuals who contributed to the report and who gave many helpful suggestions:

Fernand Prevost
Director, Mathematics Education
New Hampshire State Department of Education
Concord, New Hampshire

Donald Randall
New England Educational Assessment Project
New Hampshire State Department of Education
Concord, New Hampshire

George Spooner
Department of Mathematics
Central Connecticut State College
New Britain, Connecticut

Walter N. Durost
Department of Education
University of New Hampshire
Durham, New Hampshire

Robert Hart
Bureau of Educational Research and Testing Services
University of New Hampshire
Durham, New Hampshire

Donald Bailey
Bureau of Educational Research and Testing Services
University of New Hampshire
Durham, New Hampshire

Grateful acknowledgement is also expressed to Mrs. June Hall for her assistance in typing the rough draft and final copy and for constructing the tables.

Criticisms and constructive suggestions should be addressed to the project director, as he assumes responsibility for the contents of the final report.

A LONGITUDINAL EVALUATION OF MATHEMATICAL COMPUTATIONAL ABILITIES OF NEW HAMPSHIRE'S EIGHTH GRADERS (1963) AND EIGHTH GRADERS (1967)

List of Tables

Table	Title	Page
1	A Comparison of Means For The Otis Quick-Scoring Mental Abilities Test: Gamma	4
2	A Comparison of Means For The Metropolitan Achievement Test: Computation	5
3	A Comparison of Means For The Metropolitan Achievement Test: Mathematical Concepts	6
4	A Comparison of School and College Ability Test	10
5	A Comparison of Stanford Paragraph Meaning, Spelling and Language Tests	11
6	A Comparison of Stanford Arithmetic: Computation, Concepts and Applications Tests	12
7	A Comparison of Stanford Social Studies and Science Tests	13
8	A Comparison of Selected Percentiles for School and College Ability Test	15
9	A Comparison of Selected Percentiles for Stanford Paragraph Meaning, Spelling, Language	16
10	A Comparison of Selected Percentiles for Stanford Arithmetic: Computation, Concepts and Applications Tests	17
11	A Comparison of Selected Percentiles for Stanford Social Studies and Science Test	18

List of Normal Percentile Charts

Chart	Title	Page
I	SCAT Verbal	19
II	SCAT Quantitative	20
III	SCAT Total	21
IV	Stanford Paragraph Meaning	22
V	Stanford Spelling	23
VI	Stanford Language	24
VII	Stanford Computation	25
VIII	Stanford Concepts	26
IX	Stanford Applications	27
X	Stanford Social Studies	28
XI	Stanford Science	29

In the fall of 1963, under the direction of Dr. Walter N. Durost, the Test Service and Advisement Center conducted the sixth consecutive yearly statewide testing program at grade eight for the New Hampshire State Department of Education. The program consisted of a mental abilities test, the Otis Quick-Scoring Test, Gamma, Form Fm and the Metropolitan Advanced Battery, Form Bm.

The research reported in this paper was conducted with the sponsorship of the New Hampshire State Department of Education and a grant from the United States Office of Education, grant number OEG-1-9-090023-0106 (010). The purpose of the research was to evaluate empirically the effects of using different mathematics text books on the mathematical computational ability of students as a method of assessing the effectiveness of different mathematics instruction, where it is assumed that the choice of text reflects methods of teaching.

In his 1963 report, Dr. Durost indicates that the median raw score for the state of New Hampshire in arithmetic computation was 34 raw score points. The equivalent standard score was 55 and the grade equivalent was 8.8. This was consistent with a pattern that had been established for some years. In 1961, for instance, the median grade equivalent was 8.7 and in 1962 it was 8.7, so I believe it is safe to say that for a period of years New Hampshire, in its 8th grade testing program, which was conducted in November, was rather markedly above the national norm in terms of its achievement in the area of arithmetic computation.

In 1964 the pattern changed markedly. The median raw score for New Hampshire dropped to 31 raw score points, providing a standard score of 52 and a grade equivalent of 8.3. In his 1964 report, Dr. Durost makes the following statement:

> "It is suspected that the adoption of the new curriculum in mathematics in New Hampshire may have resulted in the drop in Arithmetic Computation. This influence has been noted in other studies in communities where data are available over a period of years and where the new curriculum has recently been introduced."[1]

In 1965 the 8th grade testing program was conducted by the Bureau of Educational Research and Testing Services at the University of New Hampshire. The state report of that year indicates that the median raw score for the state of New Hampshire in the arithmetic computation subtest of the Metropolitan was 30. This equalled a grade equivalent of 8.1 which indicated a continuing drop in New Hampshire's arithmetic computational ability. As a result of that finding the State Department of Education authorized the Bureau to conduct a study which would attempt to determine whether in fact the introduction of modern mathematics was having a detrimental effect on the computational ability of New Hampshire's 8th graders. The study was conducted in the following manner: in 1965 the total number of students tested in the state was 4,724. Of this number, 4,182 were included in the study. The 8th grade classes which participated in this voluntary statewide program were placed in one of four categories which were designated as follows:

modern, traditional, transitional and other. 542 students were eliminated from the study by being placed in the category called other. Placement in these three groups was primarily done on the basis of the text the school system had been using for three years previous to the 1965 eighth grade year. In other words, the texts the student used in grades 5,6, and 7 were identified as being either traditional, transitional or modern. The assignment of the texts and the school systems into one of these four groups was done by Mr. Fernand Prevost, Director of Mathematics Education, New Hampshire State Department of Education. This classification is, at best, a very subjective one but the following have been used as working definitions for this study of modern, traditional and transitional mathematics:

> Working Definitions for Classifying Schools Based on Texts
>
> If the mathematics text used by the school showed no deviation from methods of presentation common in the late 1950's or early 1960's, and introduced a minimal amount of new math, it was judged to be traditional. Such texts were more frequently filled with long exercise sections; little structure or rationale in concept development was emphasized.
>
> Texts which tended to approximate the California strand development were judged to be modern. Such texts placed stress on the development of concepts and concrete manipulations. Texts emphasizing mathematical systems, properties, functions and graphing, for example, met the criteria for modern.
>
> Those texts which the publisher had admitted, or which Mr. Prevost judged, to have a middle of the road approach were considered transitional. These texts were somewhere along the continuum of traditional to modern.
>
> Where a school system did not fit into a category it was eliminated from the study.

Using the raw scores on the Otis-Gamma intelligence tests, a one-way analysis of variance was computed looking for differences among these three groups. (Ferguson, 1959). This analysis indicated there was a significant difference in mean raw scores among the three groups. The computed F was 14.81 which is significant beyond the .01 level. Following the analysis of variance, T tests were run among the three groups on their intelligence scores. The results of this analysis indicated there was a significant difference in intelligence beyond the .01 level between students in the modern mathematics group and those in the traditional mathematics group, favoring the modern group. It was found that there was a significant difference at the .01 level between those students studying modern mathematics and those studying transitional mathematics, again favoring the modern group. It was found there was a significant difference at the .05 level between those students studying traditional mathematics and those studying transitional mathematics, favoring the transitional group. The means, as well as the computed F's and T's, are given in Table 1.

The same procedure was followed in looking for significant differences among the three groups in the area of mathematics, as measured by the Metropolitan Achievement Test, using the computation and concepts subtests of the battery. The analysis of the computation scores on the Metropolitan Achievement Test indicated there was a significant difference among the means for computational abilities of the three groups. The computed F was 6.87 which is significant beyond the .01 level.

Following the analysis of variance, T tests were run between the three groups on their computation scores. There was a significant difference between the modern mathematics group and the traditional group which was significant at the .01 level. There was a significant difference between the modern mathematics students and the transitional students at the .05 level. There was a significant difference between the traditional students and the transitional students which was significant at the .05 level. The means as well as the computed F's and T's are given in Table 2.

The data from the Metropolitan Achievement Test, subtest Mathematical Concepts, was also analyzed but no significant difference was found among the three groups. The reported F is .99. The means as well as the computed F are given in Table 3.

The results of these two analyses indicate that there was a significant difference among the three groups based on their IQ. The difference favored the students studying modern mathematics, followed by those studying transitional mathematics, followed by those studying traditional mathematics. When one looks at the differences in computational ability one finds here, too, there is a significant difference, only in reverse. The students who have studied traditional mathematics did significantly better than those who studied transitional mathematics and those who studied modern mathematics. Those who studied transitional mathematics did better than those who studied modern mathematics.

Table 1

A COMPARISON OF MEANS FOR THE OTIS QUICK-SCORING MENTAL ABILITIES TEST: GAMMA

Fall 1965

	MODERN	TRADITIONAL	TRANSITIONAL
Number of Students	1215	591	2376
OTIS Means	36.69	33.59	34.70

Analysis of Variance

F = 14.81

.01 level of significance 4.60

T Tests	Modern : Trad.	Modern : Trans.	Traditional : Transitional
	4.96	4.27	2.15
Significant	.01	.01	.05

Table 2

A COMPARISON OF MEANS FOR THE METROPOLITAN ACHIEVEMENT TEST: COMPUTATION

Fall 1965

	MODERN	TRADITIONAL	TRANSITIONAL
Number of Students	1215	591	2376
COMPUTATION Means	28.56	30.08	29.22

Analysis of Variance

F = 6.87

.01 level of significance 4.60

T Tests	Modern : Trad.	Modern : Trans.	Traditional : Transitional
	3.65	2.26	2.26
Significant	.01	.05	.05

Table 3

A COMPARISON OF MEANS FOR THE METROPOLITAN ACHIEVEMENT TEST: MATHEMATICAL CONCEPTS

Fall 1965

	MODERN	TRADITIONAL	TRANSITIONAL
Number of Students	1215	591	2376
MATHEMATICAL CONCEPTS Means	29.17	29.34	28.87

Analysis of Variance

F = .99

Not Significant

In the fall of 1967 the statewide eighth grade testing program was again conducted. This is the tenth consecutive year of this program and the fifth year of this particular study. The tests used in the 1967 testing at grade eight were the following: The School and College Ability Test, Form 3B and the Stanford Achievement Test, Advanced Form W. The tests used in the eighth grade testing program had been changed subsequent to the 1965 testing because it was felt that the Stanford Achievement Test might more adequately measure students' ability in arithmetic computation. It was a much more recently normed test than the Metropolitan and therefore hopefully would reflect more of the "modern Mathematics material" and thereby give a more honest picture of what New Hampshire's students' abilities were, in the area of mathematical computation.

It is noted in the 1967 report of the eighth grade testing program, edited by Dr. Gilbert Austin, that mathematics computation has continued to drop. In 1966, using the Stanford, the median grade equivalent had dropped to 7.8. In 1967, again using the Stanford, it had dropped to 6.8. Because of this very significant drop, in terms of grade equivalents, from 1963 - 1967, (the median grade equivalent, in 1963, using the Metropolitan, being 8.8; the median grade equivalent, in 1967, using the Stanford, being 6.8--a two-year drop in terms of grade equivalents--) it was decided by the author that a replication of the 1965 study would be appropriate to see whether there still were significant differences in the intellectual ability as well as the computational ability of students in grade 8, again classified by the kind of textbooks they were using. It should be noted here, in terms of the grade equivalents just mentioned above, that it is not truly possible to compare grade equivalents based on the Metropolitan with grade equivalents based on the Stanford since there are serious norming problems in terms of the two different tests. The technical supplement provided by Harcourt, Brace and World, equating these two tests in terms of grade equivalents, provides the following data: the 1963 grade equivalent of 8.8 on the Metropolitan is equated with an 8.6 grade equivalent on the Stanford. This is done using the 1963 data. If one uses the 1967 data and goes in the opposite direction and takes the Stanford Achievement Test grade equivalent in arithmetic computation which is 6.8, and looks up the Metropolitan grade equivalent, one finds it at 7.5. Therefore we have two possible ways of viewing this data. One may subtract the 1967 equated Metropolitan score from the 1963 Metropolitan grade equivalent; this subtraction, which is 8.8 (1963), minus 7.5, (1967) leaves, in the five year period, a 1.3 year grade equivalent drop. If one uses Stanford to do the subtraction, then one finds he must subtract the 1967 median grade equivalent of the Stanford of 6.8 from the 1963 Stanford grade equivalent of 8.6. This subtraction yields a drop in grade equivalent scores of 2 years.

The following is a discussion of how the replication of the study was conducted. The principal investigator and Mr. Fernand Prevost, Mathematics Consultant for the State Department of Education (New Hampshire) who had worked together on the original study in 1965, spent a considerable amount of time working on the question of the classifying of the schools in this eighth grade population into four groups: traditional, transitional, modern and other. It was finally decided that the best way to do this would be to create a questionnaire for the schools covering the 5th, 6th and 7th grades. This questionnaire would list all of the presently available commonly used mathematics textbooks. Mr. Prevost agreed to develop this mathematics text list from which a questionnaire was created. A sample of this questionnaire may be found in the appendix of this report. The questionnaire for grades five and six included 17 texts; the questionnaire for grade seven included 13 texts. A total of 107 questionnaires were mailed to the school systems participating in the 1967 grade 8 testing program. Of this number, 91 questionnaires were returned. This represents a percentage return of 85%. Having collected the data from the schools, information was compiled and sent to Mr. Prevost for further refinement and for the categorization of the school systems into one of four groups. In assigning school systems into one of the four groups, Mr. Prevost used essentially the definitions of modern, traditional and transitional which were used in 1965 and which were reported earlier in this study. When that selection was completed the data was statistically analyzed in the following manner: a complete analysis of variance was done across each of the three groups using the School and College Ability Test and the Stanford Achievement Test. The following are the results of that analysis.

There was a significant difference among the three groups as measured by the School and College Ability Test on their verbal skills, F = 18.53; their quantitative skills, F = 15.71; and their total score, F = 19.88. All of these differences favored the modern group. Following this analysis a series of T tests was conducted and it was found there was a significant difference between the modern and traditional group and the modern and transitional group on all of the tests except the SCAT Quantitative, in which there was no difference between the modern and the traditional students. The differences between the traditional and the transitional group were not significant. The means as well as the computed F's and T's are given in Table 4.

There was a significant difference among the three groups as measured by the first three tests of the Stanford Achievement Test; these tests being Paragraph Meaning, Spelling and Language tests. The computed F's are: 20.50 for Paragraph Meaning; 11.91 for Spelling; 13.98 for Language. The means for these three subtests all favor the modern group. Following this analysis a series of T tests was conducted and it was found that on Paragraph Meaning there was a significant difference between the modern and traditional groups and the modern and transitional group. There was a non-significant difference between the traditional and the transitional group.

On Stanford Spelling there was a non-significant difference between the modern and the traditional group, a significant difference between the modern and the transitional group and a non-significant difference between the traditional and the transitional group. On Stanford Language there was a significant difference between the modern group and the traditioonal group and between the modern and the transitional group. There was a non-significant difference between the traditional and the transitional group. The means as well as the computed F's and T's are given in Table 5.

There was a significant difference among the three groups as measured by the three Arithmetic subtests of the Stanford, these tests being Arithmetic

Computation, Arithmetic Concepts and Arithmetic Applications. The computed F for Arithmetic Computation is 11.78; for Concepts, it is 19.95 and for Applications it is 15.01. Following this analysis a series of T tests was conducted and it was found that on Arithmetic Computation there was a non-significant difference between the modern and the traditional group, a significant difference between the modern and the transitional group and a significant difference between the traditional and the transitional group. It should be noted here that this difference favored the modern group. On the Concepts subtest there was a significant difference between the modern and the traditional group and between the modern and the transitional group. There was a non-significant difference between the traditional and the transitional group. This difference favored the modern group. On the Applications subtest of the Stanford there was a non-significant difference between the modern and the traditional group, a significant difference between the modern and the transitional group and a non-significant difference between the traditional and the transitional group. It should be noted that this difference favored the modern group. The means as well as the computed F's and T's are given in Table 6.

There was a significant difference among the three groups as measured by the Stanford Social Studies Test and as measured by the Stanford Science Test. The F for Stanford Social Studies was 9.89 and for Stanford Science 12.81. Following this analysis a series of T tests was conducted and it was found that on Stanford Social Studies there was a significant difference between the modern and traditional group and between the modern and the transitional group. There was a non-significant difference between the traditional group and the transitional group. On Stanford Science there was a significant difference between the modern and the traditional group and the modern and the transitional group. There was a non-significant difference between the traditional and the transitional group. The difference in the means in all cases favored the modern group. The means as well as the computed F's and T's are found in Table 7.

It is interesting to note that in the 1967 study of the eighth grade we find that the pattern is totally consistent. The modern group is not only intellectually superior as it was in the 1965 group, but it is also academically superior as measured by the 8 subtests of the Stanford Achievement Test. Of particular interest, it is academically superior in the area of mathematics, in all three cases, Computation, Concepts and Applications.

Table 4

A COMPARISON OF SCHOOL AND COLLEGE ABILITY TEST

GRADE 8: Fall 1967

	SCAT Verbal		SCAT Quantitative		SCAT Total	
Modern Mean Group 1	32.60		21.89		54.49	
Traditional Mean Group 2	30.06		21.21		51.27	
Transitional Mean Group 3	30.62		20.45		51.06	
F's	18.528		15.713		19.875	
Significant	.01		.01		.01	
T's and Significance						
1 : 2 =	4.358	.01	1.689	NS	3.599	.01
1 : 3 =	5.325	.01	5.607	.01	5.994	.01
2 : 3 =	0.940	NS	1.853	NS	0.222	NS

Table 5

A COMPARISON OF STANFORD PARAGRAPH MEANING, SPELLING AND LANGUAGE TESTS

GRADE 8: Fall 1967

	Stanford P.M.		Stanford Spelling		Stanford Language	
Modern Mean Group 1	34.05		30.53		95.77	
Traditional Mean Group 2	31.74		29.74		93.69	
Transitional Mean Group 3	31.96		28.78		92.47	
F's	20.507		11.914		13.980	
Significant	.01		.01		.01	
T's and Significance						
1 : 2 =	4.151	.01	1.402	NS	2.114	.05
1 : 3 =	5.869	.01	4.881	.01	5.254	.01
2 : 3 =	0.396	NS	1.682	NS	1.219	NS

Table 6

A COMPARISON OF STANFORD ARITHMETIC: COMPUTATION, CONCEPTS AND APPLICATIONS TESTS

GRADE 8: Fall 1967

	Stanford Computation	Stanford Concepts	Stanford Applications
Modern Mean Group 1	19.00	20.50	14.94
Traditional Mean Group 2	18.75	18.80	14.65
Transitional Mean Group 3	17.81	19.22	14.42
F's	11.775	19.952	5.012
Significant	.01	.01	.01
T's and Significance			
1 : 2 =	0.633 NS	4.641 .01	1.103 NS
1 : 3 =	4.787 .01	5.448 .01	3.160 .01
2 : 3 =	2.376 .05	1.134 NS	0.902 NS

Table 7

A COMPARISON OF STANFORD SOCIAL STUDIES AND SCIENCE TESTS

GRADE 8: Fall 1967

	Stanford Social Studies		Stanford Science	
Modern Mean Group 1	48.16		33.02	
Traditional Mean Group 2	46.22		31.72	
Transitional Mean Group 3	46.38		31.60	
F's	9.894		12.813	
Significant	.01		.01	
T's and Significance				
1 : 2 =	2.846	.01	2.827	.01
1 : 3 =	4.097	.01	4.839	.01
2 : 3 =	0.227	NS	0.255	NS

In the mathematical development of the analysis of variance, a number of assumptions are made. One assumption is that the distribution of variables and the polulation from which the samples are drawn are normal. Since this study is not based upon the drawing of a sample from a population, but is, in fact, a population itself, the use of analysis of variance can seriously be questioned. Because of the failure to meet this requirement, the project director, in consultation with other statisticians, decided that to pursue the project as originally proposed, the analysis of co-variance for the 1965-67 study would be inappropriate since the assumptions for simple analysis are not met. The assumptions are certainly not met for the analysis of co-variance; therefore, it was decided that the 1967 grade 8 data would be subjected to further analysis by computing selected percentile ranks as a basis for determining differential effects for above and below average students.

Five selected percentiles were chosen for this study: they are the 90th, 75th, 50th, 25th, and 10th. The comparisons that are provided in the following tables indicate the raw scores at each of these selected percentiles for the students involved in the study. In the entire state in 1967 there were 7,139 students tested. In this study there were 4,658. Of that number, 2,269 were classified as modern; 514 were classified as traditional; and 1,875 were classified as transitional. Tables 8 - 11 present the comparisons for these three groups in terms of selected percentiles. We have also prepared normal percentile charts which visually present the same information. These will be found in the following charts, I - XI.

Table 8 and Chart I clearly indicate that we are dealing with three distinct populations, at least as measured by the SCAT Verbal portion of this test. Only at the 75th percentile do the traditional and transitional groups attain the same scores. Other than that, the modern group performance is superior to the transitional and the transitional superior to the traditional group. On the SCAT Quantitative test the picture is not quite as clear. At the 10th, 25th, and 50th percentiles the modern group separates and becomes the superior group. The transitional group starts off more poorly than either the modern or the traditional group and only at the 90th percentile crosses the traditional group's line and has the superior score. On the SCAT Total test the modern group is again clearly different from the other two groups. The traditional and transitional group overlap at the 25th and 75th percentiles. The results of this analysis on the School and College Ability Test would seem to clearly indicate that at all levels the modern group is superior intellectually to the other two groups and that in general the transitional group is superior to the traditional group.

On the first three tests of the Stanford Achievement Test, (Paragraph Meaning, Spelling and Language), the same pattern is consistently followed. The modern and the traditional group at the 10th percentile are equal. At the 25th percentile the traditional group is superior. At the 50th percentile and the 75th percentile they are similar. At the 90th percentile the modern group is clearly superior while the traditional group has now dropped below the standing of the transitional group. The transitional group at the 10th, 25th, 50th, and 75th percentile was poorer than either the modern or the traditional group and only at the 90th percentile does it pass the traditional group. On the Stanford Arithmetic Applications subtest there are no differences among any of the three groups at the 10th, 25th or 50th percentile. At the 75th percentile there is no difference between the modern and the traditional group. However, at the 90th percentile the modern group is superior. At the 75th percentile the transitional group is performing more poorly than either of the other two groups; at the 90th percentile it is scoring equally well with the traditional group.

On the Social Studies and the Science subtests of the Stanford the pattern once again re-emerges of the modern group being markedly superior to the other groups. On the Social Studies subtest of the Stanford the modern group is superior at all percentile levels to the other two groups and only at the 25th percentile do the traditional and the modern groups perform equally well on the Science subtest. At all other levels the modern group is superior to the other two. Again, as has been the case in earlier subtests, the traditional and the transitional groups tend to overlap each other at various percentiles.

Table 8

A COMPARISON OF SELECTED PERCENTILES FOR SCHOOL AND COLLEGE ABILITY TEST

GRADE 8: Fall 1967

NAME OF TEST	SELECTED PERCENTILES IN RAW SCORES				
	10th	25th	50th	75th	90th
SCAT Verbal					
Modern Group	16	23	33	41	48
Traditional Group	14	20	29	39	46
Transitional Group	15	21	30	39	47
SCAT Quantitative					
Modern Group	12	15	20	27	33
Traditional Group	12	15	20	26	31
Transitional Group	10	14	19	25	32
SCAT Total					
Modern Group	31	40	54	67	79
Traditional Group	29	37	50	64	75
Transitional Group	27	37	49	64	76

Table 9

A COMPARISON OF SELECTED PERCENTILES FOR STANFORD PARAGRAPH MEANING, SPELLING, LANGUAGE

GRADE 8: Fall 1967

NAME OF TEST	SELECTED PERCENTILES IN RAW SCORES				
	10th	25th	50th	75th	90th
STANFORD Paragraph Meaning					
Modern Group	18	25	34	43	49
Traditional Group	17	22	31	40	47
Transitional Group	16	23	31	40	47
STANFORD Spelling					
Modern Group	16	21	29	39	47
Traditional Group	15	21	28	37	46
Transitional Group	14	19	27	37	45
STANFORD Language					
Modern Group	68	81	97	111	120
Traditional Group	66	77	95	109	120
Transitional Group	65	78	93	108	118

Table 10

A COMPARISON OF SELECTED PERCENTILES FOR STANFORD ARITHMETIC: COMPUTATION, CONCEPTS AND APPLICATIONS TESTS

GRADE 8: Fall 1967

NAME OF TEST	SELECTED PERCENTILES IN RAW SCORES				
	10th	25th	50th	75th	90th
STANFORD Computation					
Modern Group	9	12	18	24	30
Traditional Group	9	13	18	24	28
Transitional Group	8	11	16	23	29
STANFORD Concepts					
Modern Group	10	14	20	26	31
Traditional Group	10	13	18	23	28
Transitional Group	9	13	18	24	29
STANFORD Applications					
Modern Group	8	10	14	18	22
Traditional Group	8	10	14	18	21
Transitional Group	8	10	14	17	21

Table 11

A COMPARISON OF SELECTED PERCENTILES FOR STANFORD SOCIAL STUDIES AND SCIENCE TEST

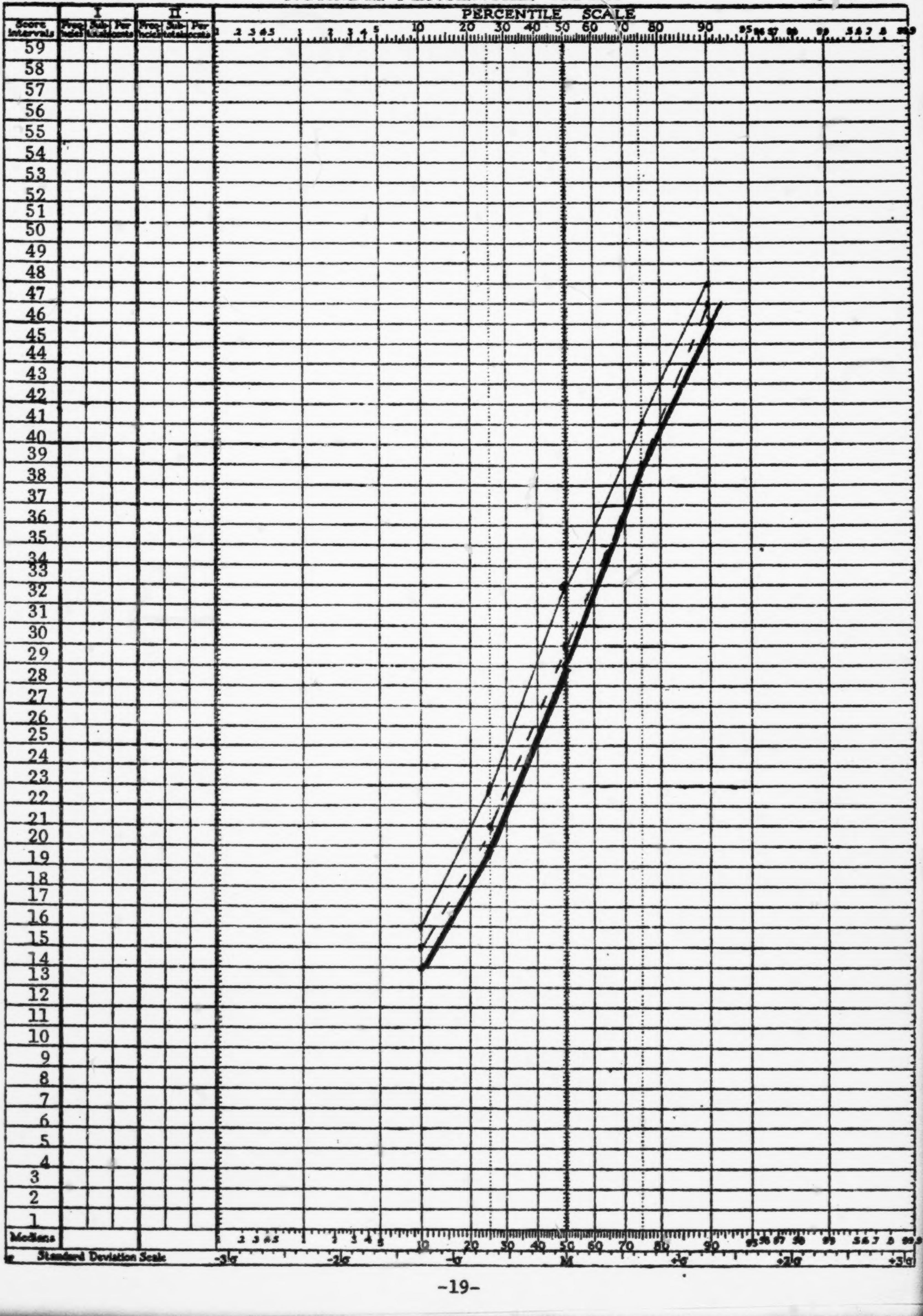
GRADE 8: Fall 1967

NAME OF TEST	SELECTED PERCENTILES IN RAW SCORES				
	10th	25th	50th	75th	90th
STANFORD Social Studies					
Modern Group	29	37	48	59	66
Traditional Group	27	35	47	56	65
Transitional Group	28	35	46	57	65
STANFORD Science					
Modern Group	20	25	33	40	45
Traditional Group	19	25	31	38	43
Transitional Group	19	24	31	38	44

SCAT VERBAL GRADE 8 MATH STUDY Chart I FALL '67

NORMAL PERCENTILE CHART

By Arthur S. Otis

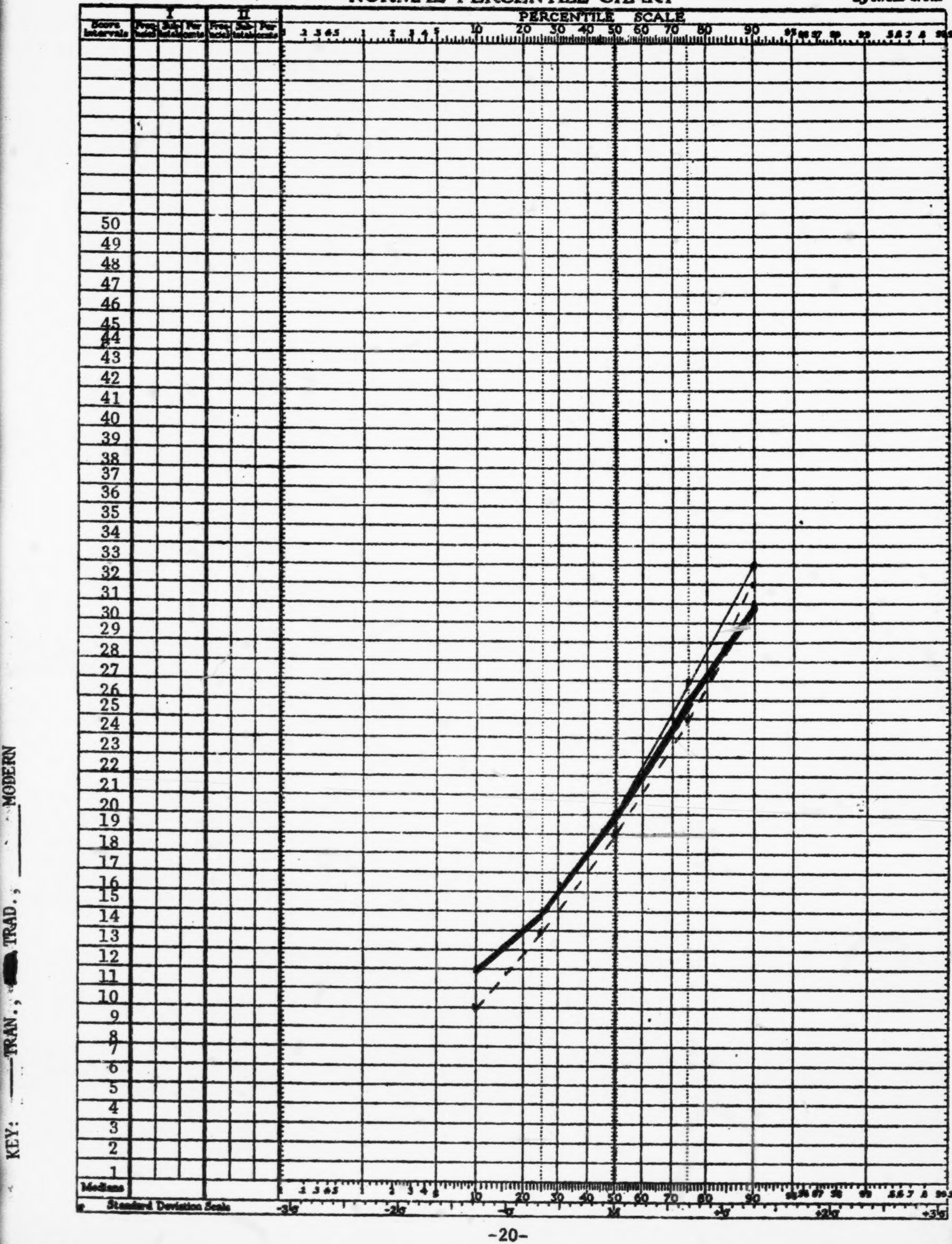


KEY: ----TRAN., ▬ TRAD., ____ MODERN

SCAT QUAN. GRADE 8 MATH STUDY Chart II fall '67

NORMAL PERCENTILE CHART

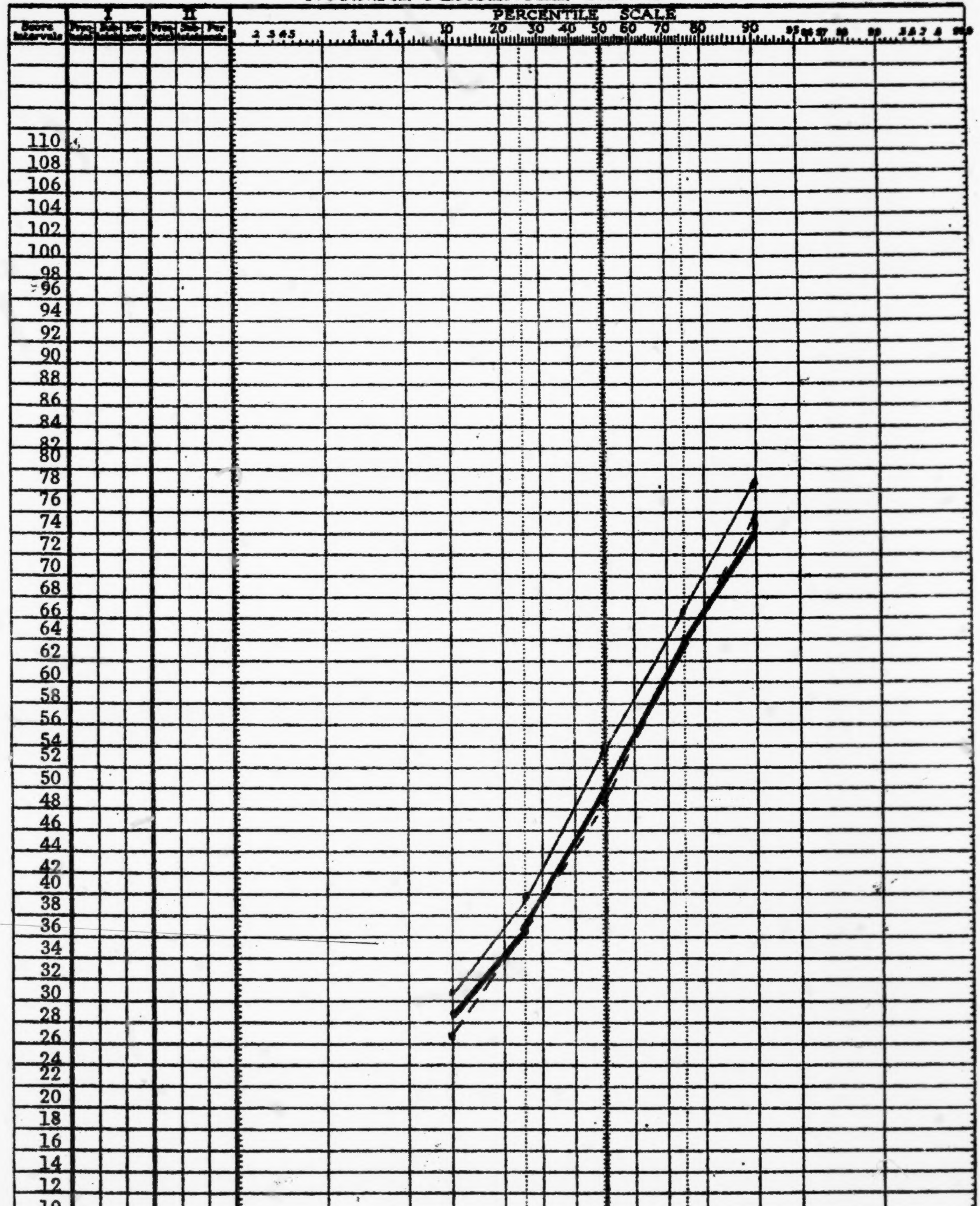
By Arthur S. Otis



SCAT TOTAL GRADE 8 MATH STUDY Chart III Fall '67

NORMAL PERCENTILE CHART

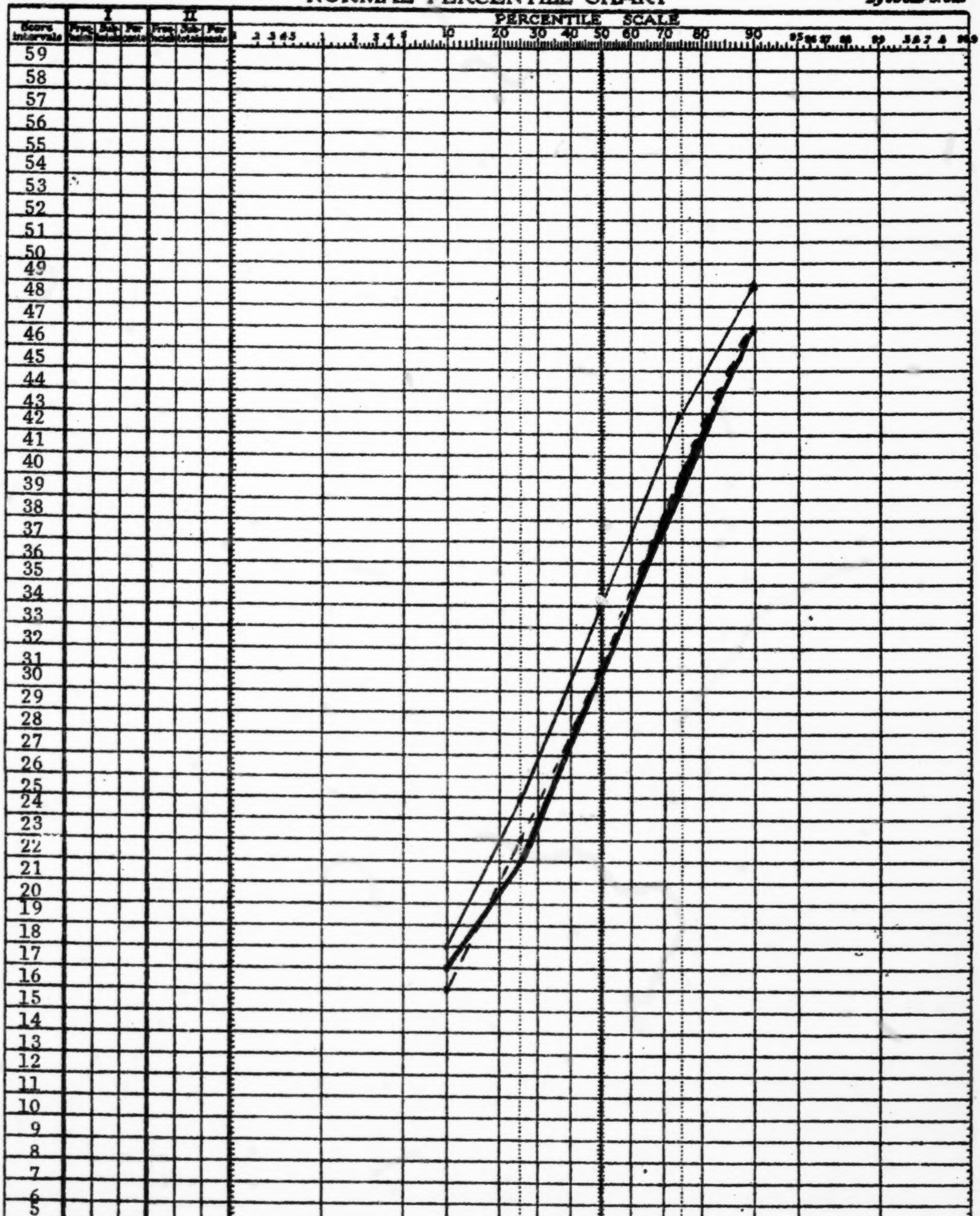
By Arthur S. Otis



STANFORD PARAGRAPH MEANING GRADE 8 - MATH STUDY Chart IV Fall '67

NORMAL PERCENTILE CHART

By Arthur S. Otis

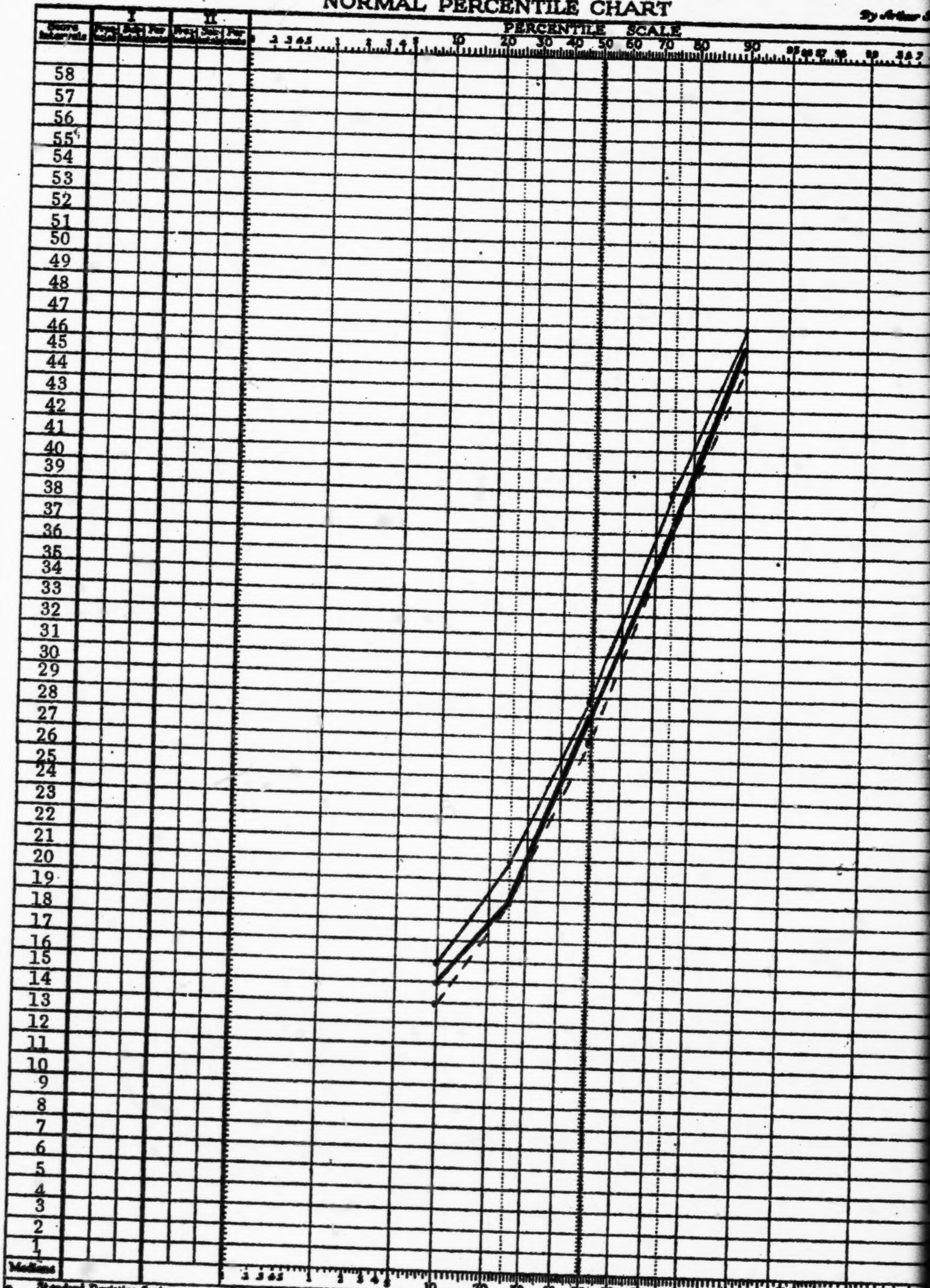


KEY: ——TRAN., ▬ TRAD., —— MODERN

STANFORD SPELLING

GRADE 8 MATH STUDY Chart V Fall '67

NORMAL PERCENTILE CHART

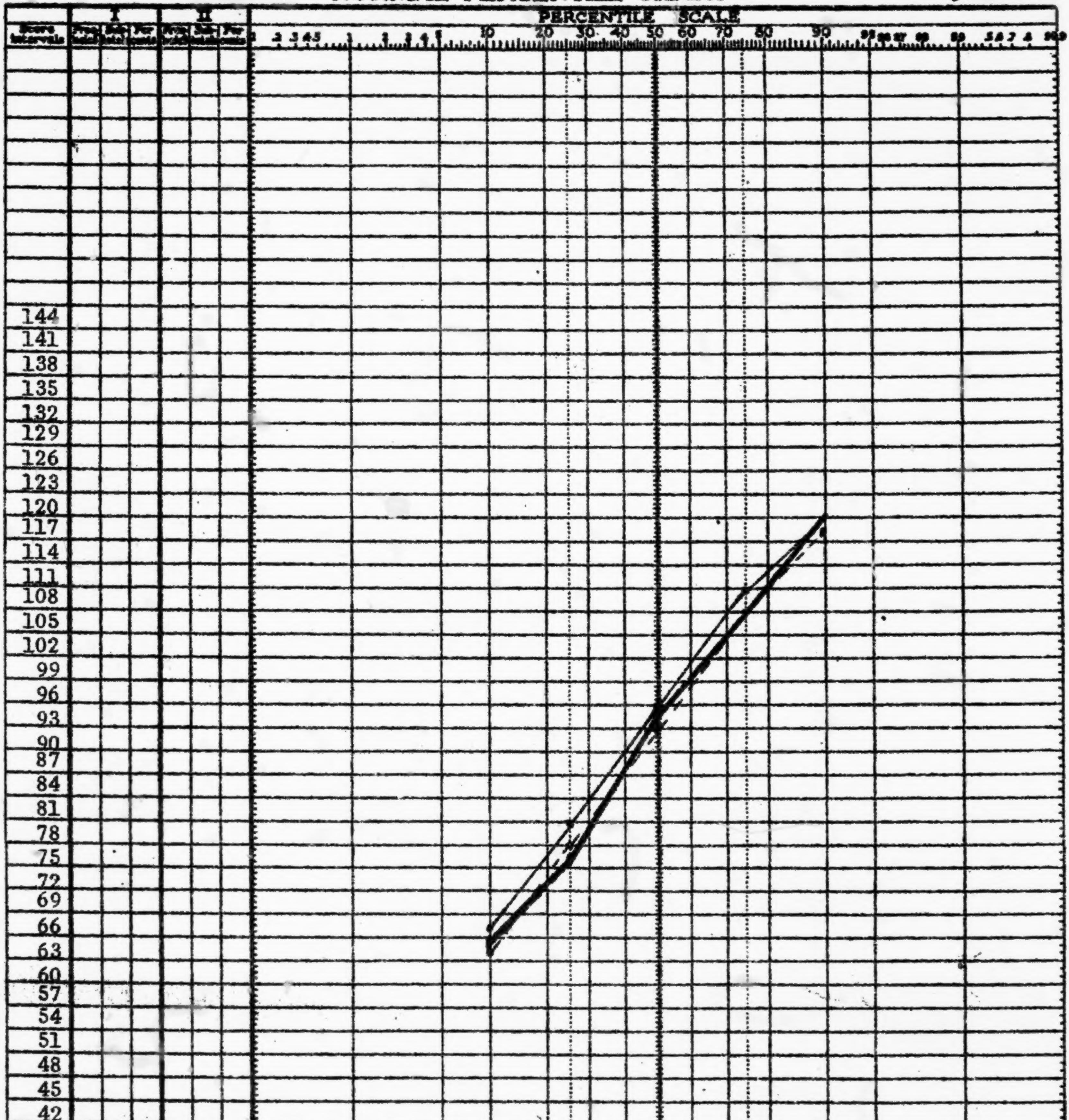


KEY: ----TRAN., ▬TRAD., ___MODERN

STANFORD LANGUAGE GRADE 8 MATH STUDY Chart VI Fall '67

NORMAL PERCENTILE CHART

By Arthur S. Otis

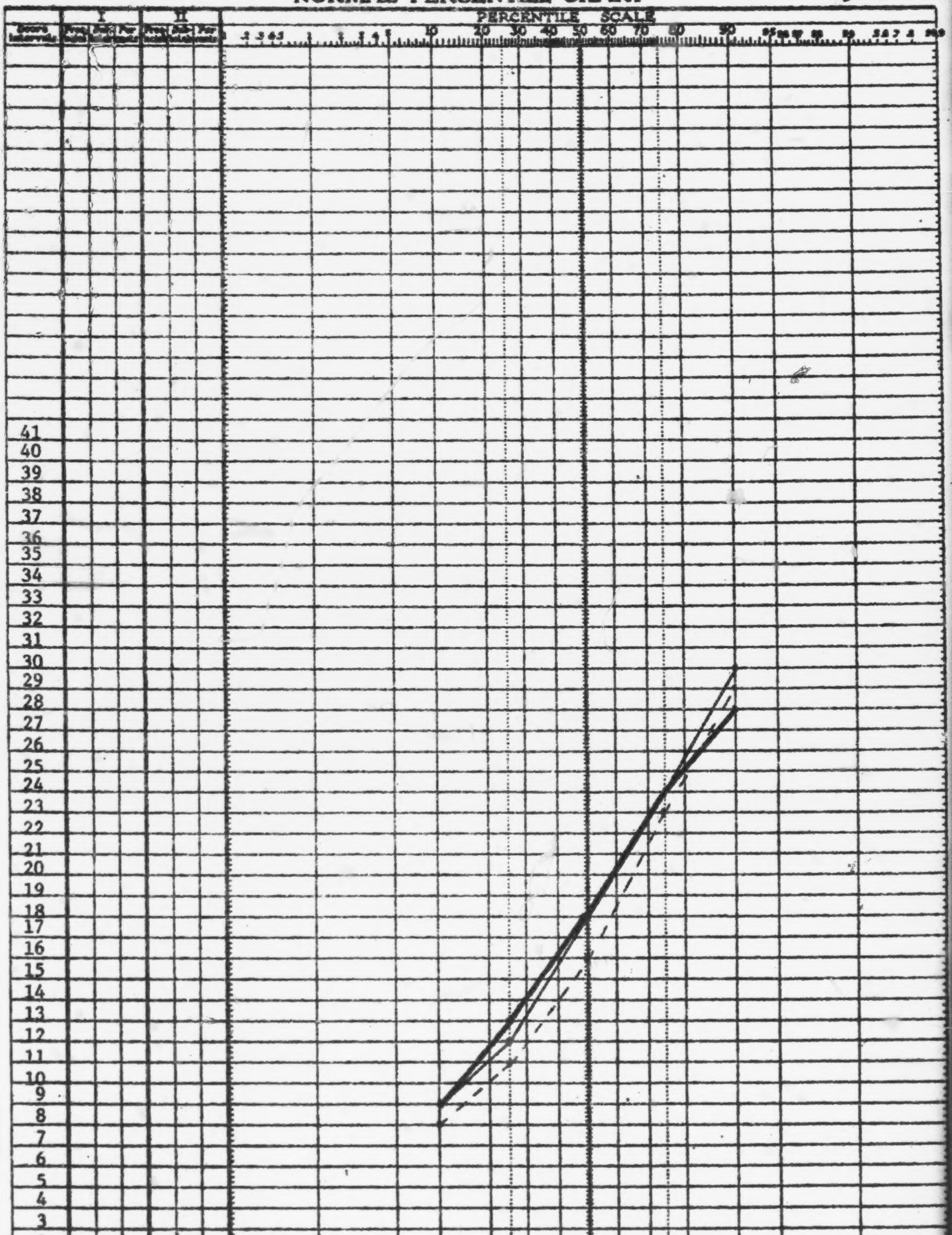


KEY: ---TRAN., ▬ TRAD. ___ MODERN

STANFORD COMP. GRADE 8 MATH STUDY Chart VII Fall '67

NORMAL PERCENTILE CHART

By Arthur S. Otis

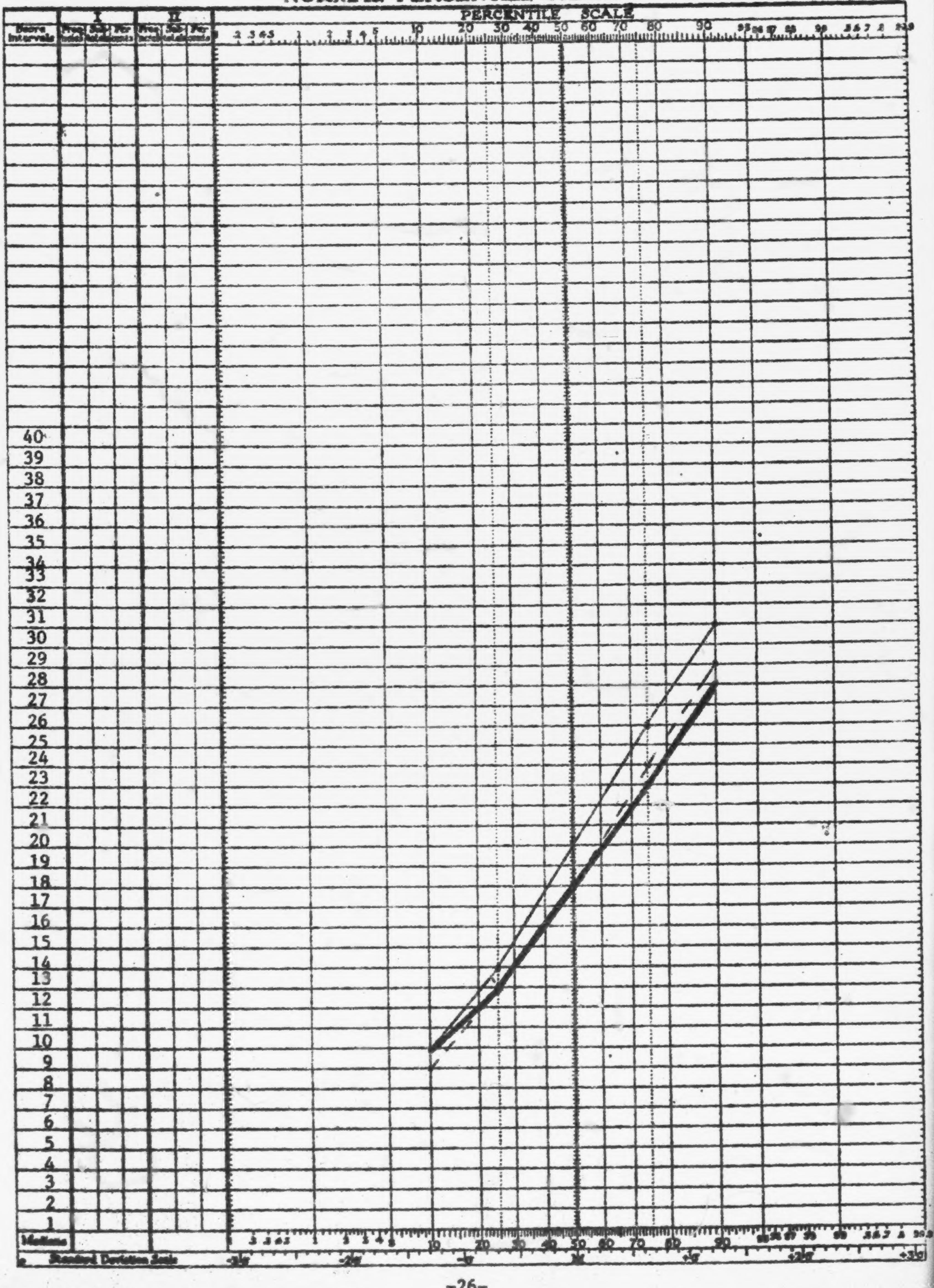


KEY: ---TRAN., ▬TRAD., ___ MODERN

STANFORD CONCEPTS GRADE 8 MATH STUDY Chart VIII Fall '67

NORMAL PERCENTILE CHART

By Arthur S. Otis



KEY: ---TRAN., ━TRAD., ___MODERN

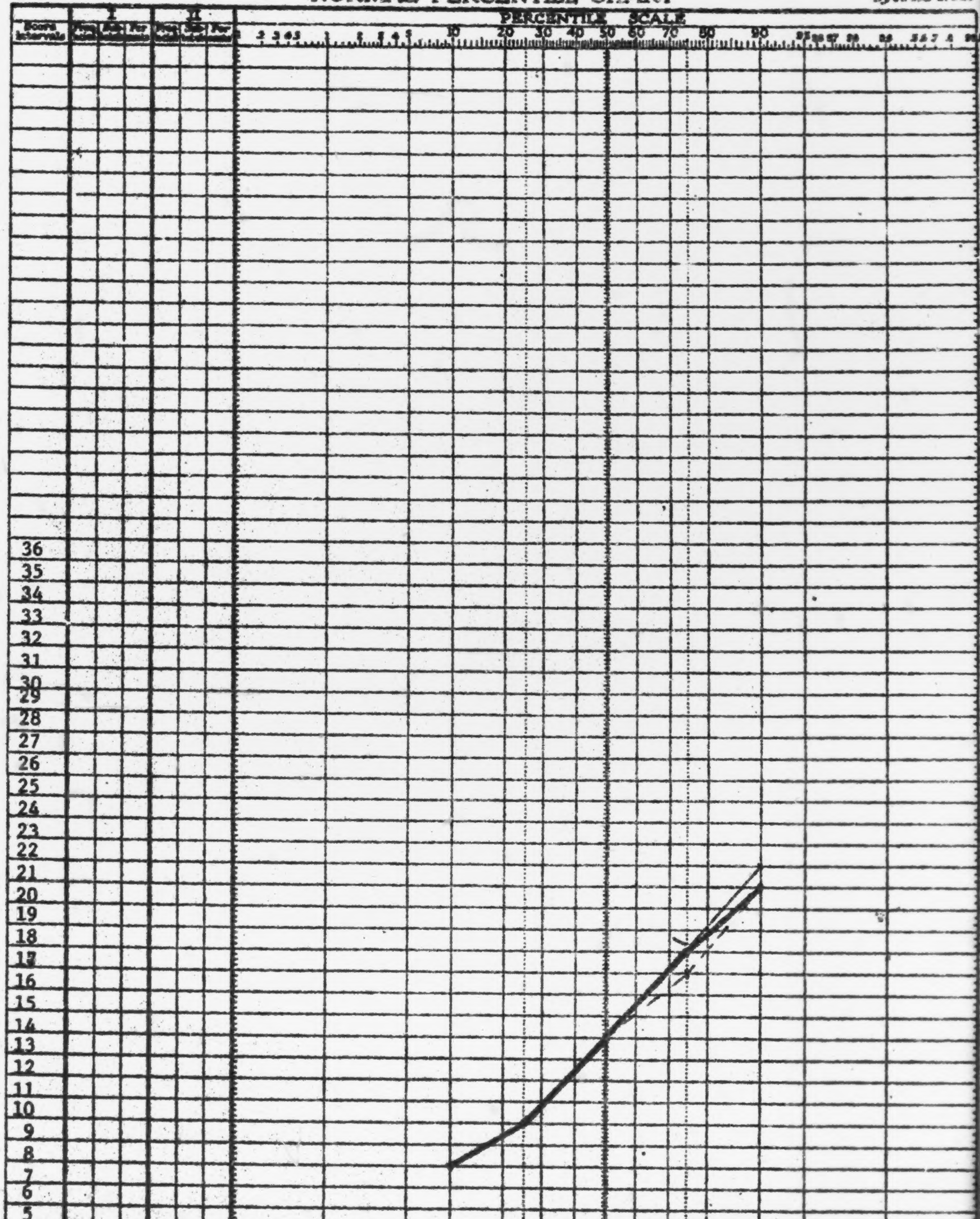
STANFORD APPLICATIONS

GRADE 8 MATH STUDY Chart IX

Fall '67

NORMAL PERCENTILE CHART

By Arthur S. Otis

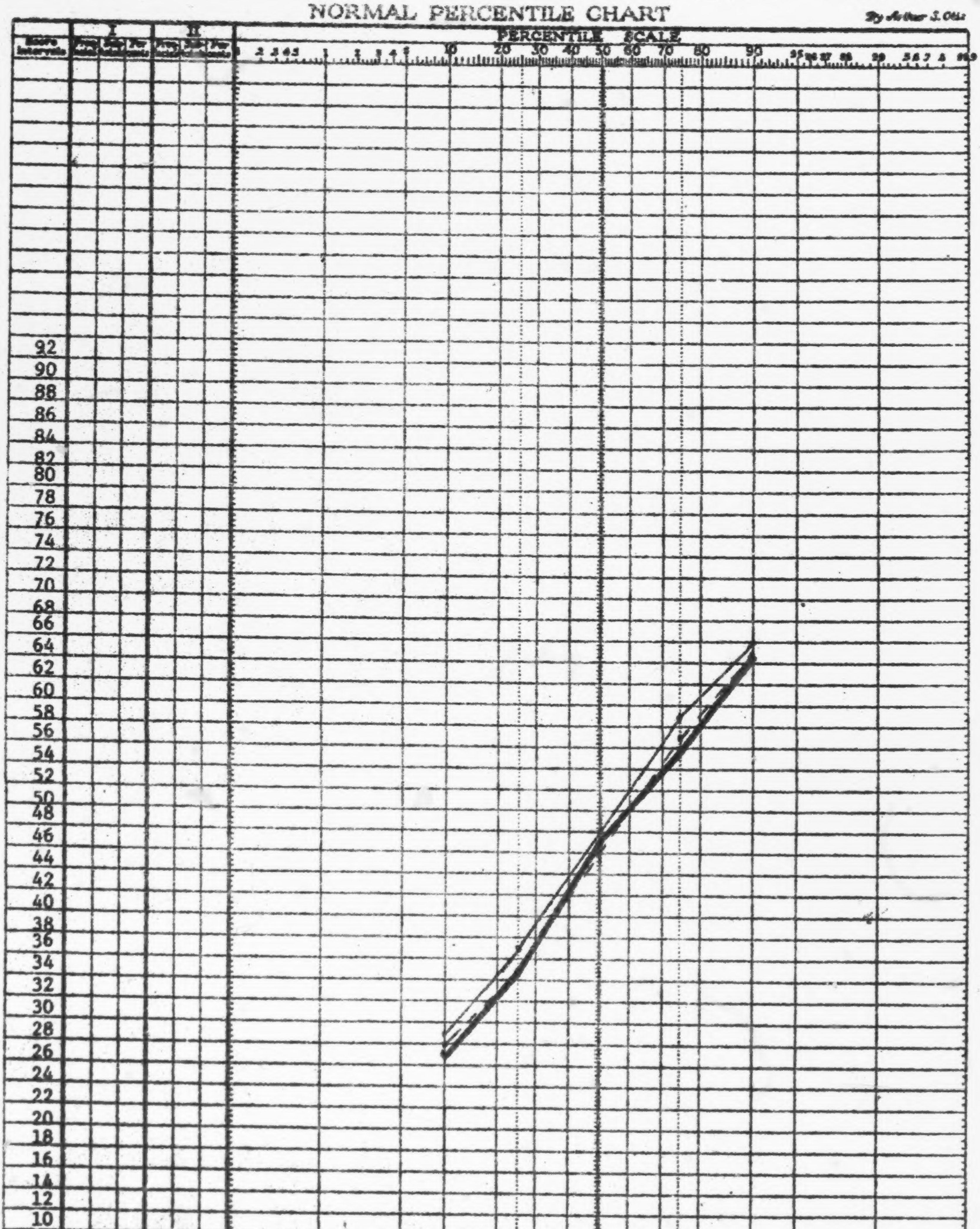


KEY: ——TRAN., —— TRAD., ____ MODERN

STANFORD SOCIAL STUDIES GRADE 8 MATH STUDY Chart X FALL '67

NORMAL PERCENTILE CHART

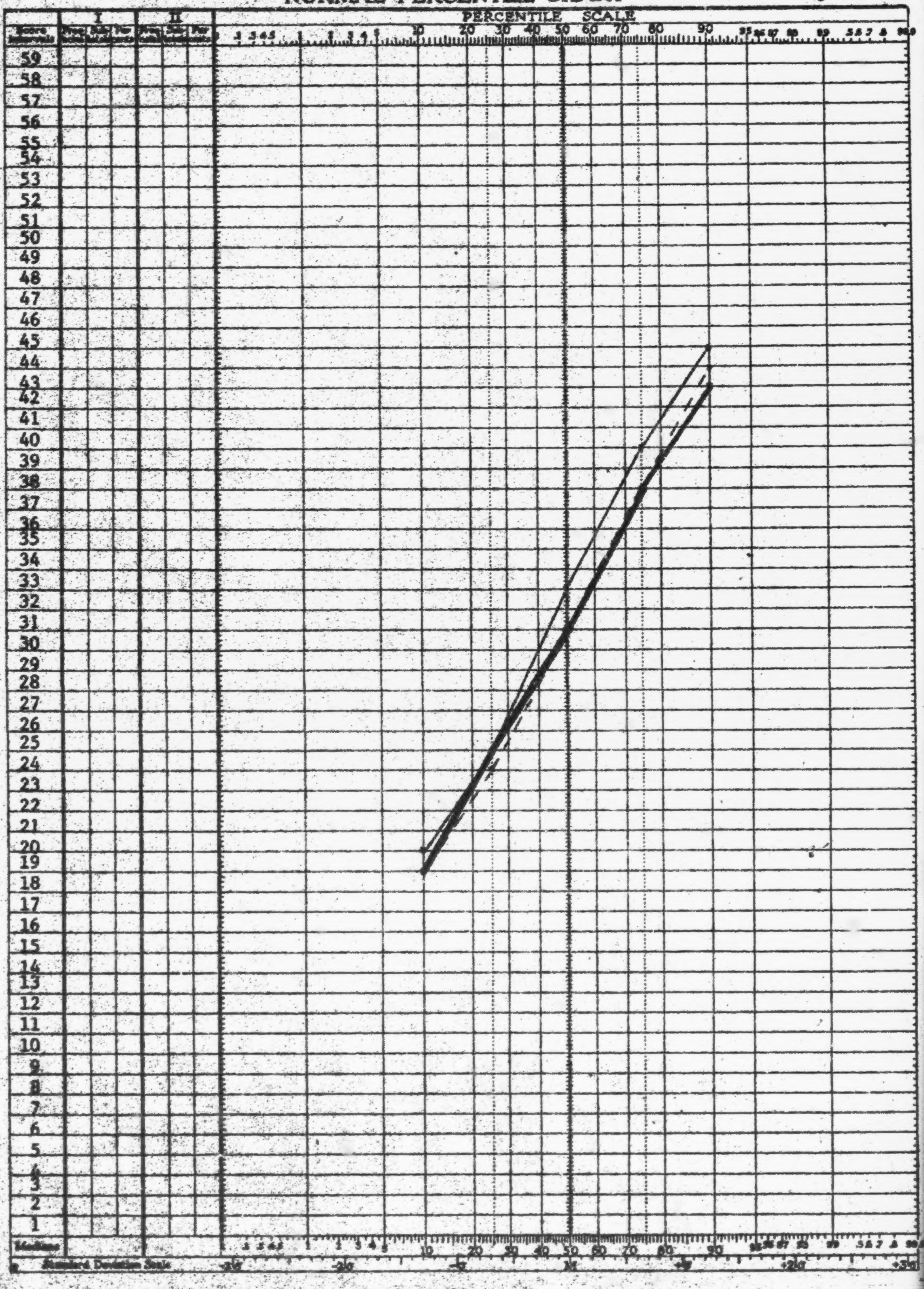
By Arthur S. Otis



STANFORD SCIENCE GRADE 8 MATH STUDY Chart XI Fall '67

NORMAL PERCENTILE CHART

By Arthur S. Otis



KEY: ---TRAD., ——TRAD., ____ MODERN

Conclusions

In 1964 it became apparent that there had been a significant drop in the arithmetic computation scores since 1963. This drop continued into 1965 when the first study authorized by the New Hampshire State Department of Education was conducted by the Bureau of Educational Research and Testing Services. The results of that study clearly indicated that for the three groups designated as modern, traditional and transitional, in intellectual skills, as measured by the Otis, the modern group was clearly superior, followed in order by the group classified as being transitional and the group classified as being traditional. On Mathematics Computation the exact inverse was true. The traditional group scored highest, followed by the transitional group, followed by the modern group. In 1967 a replication of this study was undertaken by the Bureau of Educational Research and Testing Services. The results of that study clearly indicate that again the group classified as modern is intellectually superior to the groups classified as transitional and traditional as measured by the School and College Ability Test. This finding is substantiated by the same kinds of differences and in the same direction, based on the first three tests of the Stanford Achievement battery, namely Paragraph Meaning, Spelling and Language. This again clearly indicates that the modern group is intellectually superior to the transitional or the traditional group.

On the Arithmetic subtests of the Stanford, (Computation) there seems to be markedly less difference between the modern and the traditional group than between either the modern and the transitional or the traditional and the transitional group. The transitional group seems to be achieving much more poorly than the other two groups. This is not true on the Arithmetic Concepts subtest; there the modern group clearly does better work than either the traditional or the transitional group. On the Stanford Arithmetic Applications subtest there seems to be little difference among any of the three groups at the lower selected percentiles. It is only at the upper end of the continuum that there is any real difference and at that point the modern group is clearly superior to the other two groups. The Social Studies test and the Science test tend to confirm the fact that the modern group is clearly superior to the traditional and transitional groups as they were on the SCAT and the first three subtests of the Stanford.

What seems to be true, as a result of this study, is that we are dealing with three significantly different populations, intellectually, and that the group classified as modern is clearly superior to the other two. In the area of Arithmetic Computation this difference does not hold up. The modern and the traditional group both perform at superior levels to the group classified as transitional. Perhaps this is caused by the fact that students studying in a modern text or a traditional text are at least being instructed in one systematic method while those students being instructed with a transitional text are being somewhat confused by attempting to understand modern mathematics and at the same time being taught traditional mathematics. There does not seem to be any easy explanation for this finding.

One should not lose sight, in this discussion, of the fact that scores obtained by each of these groups on the Stanford Arithmetic Computation subtest in 1967 are markedly lower than they were in 1965 and still lower than in 1963. If we look up those median scores as grade equivalents we find that the modern group and the traditional group have median scores of 18 raw score points, which are equal to grade equivalents of 7.2. The transitional group has a median score of 16 which is equal to a grade equivalent of 6.6. This pattern is similar to one we noted earlier in this paper. We can therefore safely conclude that in five years the computational ability of the students at grade 8 in New Hampshire has markedly declined. We can also reasonably safely conclude that this does not seem to be a function of the kind of textbook they are using in their classes, for this decline is almost equally great for all three groups involved in this study.

The data presented in this study clearly indicate that the type of mathematics text book used does not differentially affect (in 1967, at least) the ability of students to do computational arithmetic. However, it is the author's opinion, based upon lengthy conversations with Mr. Prevost of the State Department of Education as well as a number of teachers in a variety of schools in New Hampshire, that most teachers have in the last several years put more and more emphasis on the understanding of arithmetic and less and less time on meaningful drill and practice in the art of computation. The decline in mathematics computational ability is probably due more to the broad and generalized effect of the insistance on the part of mathematics specialists that understanding of mathematics be given a higher priority than it has been given in the past. It is a general trend in mathematics education, and the present preparation of teachers also contributes in this particular direction. There, also, the general understanding of mathematics has been stressed and so as new teachers have moved out from the training institutions, they have gone out with more concern to teach understandings and less concern with teaching computation. As stated in the beginning of this paragraph, these statements are not supported by hard data, neither are they just ideal specualation. It is suggested that it would be an appropriate kind of follow-up to this study to go and actually look at the classroom behavior of a variety of teachers and attempt to assess whether these statements are, in fact, true.

The original proposal for this study proposed that an item analysis should be done on each of the three groups. Because data was available on students who were then in 10th grade, who had been tested in 1965 at eighth grade, it was decided by the project director that he would forego the study of the item analysis and do, instead, two other studies based on computational ability. They are reported under the headings of A Longitudinal Study of Tenth Graders, 1965-1967 and A Study of Abilities and Achievements in Mathematics of Three Groups of Tenth Graders in New Hampshire. The result of those two studies seems to the project director to clearly indicate that this was a wise choice.

APPENDIX

LIST FOR GRADE 5

	SERIES NAME	PUBLISHER
______	Elementary School Mathematics	Addison-Wesley
______	Modern Mathematics Series	American Book Company
______	Discovering Mathematics	Charles Merrill Company
______	GCMP Math Program	Ed. Res. Council of Greater Cl.
______	Math Workshop for Children	Encyclopedia Britannica
______	Mathematics We Need	Ginn and Company
______	Growth in Arithmetic, Discovery Ed.	Harcourt, Brace & World
______	Elementary Mathematics	Holt, Rinehart & Winston
______	Modern School Mathematics	Houghton, Mifflin Company
______	SRA Elementary Math Program	SRA
______	GCMP Math Program	SRA
______	Contemporary Mathematics	Sadlier
______	Seeing Through Arithmetic	Scott, Foresman & Company
______	Sets and Numbers	Singer/Random House
______	Modern Math Through Discovery	Silver Burdett Company
______	Elementary Mathematics: Concepts, Properties & Operations	Webster, McGraw-Hill
______	SMSG Elementary Mathematics	Yale University Press
______	Other (Please Specify)	

This sheet prepared by________________

LIST FOR GRADE 6

	SERIES NAME	PUBLISHER
______	Elementary School Mathematics	Addison-Wesley
______	Modern Mathematics Series	American Book Company
______	Discovering Mathematics	Charles Merrill Company
______	GCMP Math Program	Ed. Res. Council of Greater Cl.
______	Math Workshop for Children	Encyclopedia Britannica
______	Mathematics We Need	Ginn and Company
______	Growth in Arithmetic, Discovery Ed.	Harcourt, Brace & World
______	Elementary Mathematics	Holt, Rinehart & Winston
______	Modern School Mathematics	Houghton, Mifflin Company
______	SRA Elementary Math Program	SRA
______	GCMP Math Program	SRA
______	Contemporary Mathematics	Sadlier
______	Seeing Through Arithmetic	Scott, Foresman & Company
______	Sets and Numbers	Singer/Random House
______	Modern Math Through Discovery	Silver Burdett Company
______	Elementary Mathematics: Concepts, Properties & Operations	Webster, McGraw-Hill
______	SMSG Elementary Mathematics	Yale University Press
______	Other (Please Specify)	

This sheet prepared by________________

LIST FOR GRADE 7

	SERIES NAME	PUBLISHER
______	Arithmetic Concepts and Skills	Addison-Wesley
______	Basic Modern Mathematics	Addison-Wesley
______	School Mathematics I	Addison-Wesley
______	Structuring Mathematics	American Book Company
______	Mathematics We Need- J-1	Ginn & Company
______	Growth in Arithmetic Discovery, Ed. 7	Harcourt, Brace & World
______	Elementary Mathematics 7	Holt, Rinehart & Winston
______	Exploring Modern Math	Holt, Rinehart & Winston
______	Modern School Math -7	Houghton Mifflin Company
______	Math for Jr. High School, Vol. I	SMSG-Yale Press
______	Contemporary Mathematics, 7	Sadlier
______	Seeing Through Mathematics I	Scott, Foresman Company
______	Modern Math Through Discovery I	Silver Burdett Company
______	Other (Please Specify)	

This sheet prepared by________________

Footnotes

[1] Durost, Walter N. Report and Summary. New Hampshire Statewide Grade Eight Testing Program. Concord, New Hampshire: Test Service and Advisement Center, November, 1964, p.9.

References

BOOKS

Ferguson, George A. Statistical Analysis in Psychology and Education. New York: McGraw-Hill, 1959.

REPORTS

Austin, Gilbert R. (ed.). *New Hampshire Eighth Grade Testing Program*. Report for school year 1967-1968, sponsored by the New Hampshire State Department of Education in cooperation with the Bureau of Educational Research and Testing Services. University of New Hampshire, 1967.

-----. (ed.). *New Hampshire Eighth Grade Testing Program*. Report for school year 1966-1967, sponsored by the New Hampshire State Department of Education in cooperation with the Bureau of Educational Research and Testing Services. University of New Hampshire, Fall, 1966.

-----. (ed.). *New Hampshire Eighth Grade Testing Program*. Report for school year 1965-1966, sponsored by the New Hampshire State Department of Education in cooperation with the Bureau of Educational Research and Testing Services. University of New Hampshire, November, 1965.

Durost, Walter N. (ed.). *Report and Summary*. *New Hampshire Statewide Grade Eight Testing Program*. Report prepared by the Test Service and Advisement Center, Concord, New Hampshire, November, 1964.

-----. (ed.). *Report and Summary*. *New Hampshire Statewide Grade Eight Testing Program*. Report prepared by the Test Service and Advisement Center, Concord, New Hampshire, November, 1963.

Dyer, Henry S., Linn, Robert L., and Patton, Michael J. *Methods of Measuring School System Performance*. Report to the New York State Education Department. Prepared by Educational Testing Service, Princeton, New Jersey, August, 1968.

Hogan, Thomas P. *Some Notes on the Performance of Pupils in Modern and Traditional Mathematics Programs on Standardized Arithmetic Tests*. Report prepared by Test Department, Harcourt, Brace and World.

References

OTHER SOURCES

Cooperative School and College Ability Tests. Princeton: Educational Testing Service, 1956-57.

Derrick, Clarence, Harris, David P. and Walker, Biron. *Cooperative English Tests*. Princeton: Educational Testing Service, 1960.

Durost, Walter N. (General Editor). *Metropolitan Achievement Tests. High School Battery*. New York: Harcourt, Brace and World, 1962.

Gardner, Eric F. *et al*. *Stanford Achievement Test*. New York: Harcourt, Brace and World, 1964.

-----. *Stanford High School Mathematics Test*. New York: Harcourt, Brace and World, 1964.

-----. *Stanford High School Numerical Competence Test*. New York: Harcourt, Brace and World, 1964.

Kelley, Truman L. *et al*. *Stanford Achievement Test. Technical Supplement*. New York: Harcourt, Brace and World, 1966.

Otis, Arthur. *Otis Quick-Scoring Mental Ability Tests*. New York: Harcourt, Brace and World, 1954.

A LONGITUDINAL EVALUATION OF MATHEMATICAL COMPUTATIONAL ABILITIES OF NEW HAMPSHIRE'S EIGHTH GRADERS (1965) AND TENTH GRADERS (1967)

List of Tables

Table	Title	Page
1	A Comparison of Means For The Otis Quick-Scoring Mental Abilities Test: Gamma	4
2	A Comparison Of Means For The Metropolitan Achievement Test: Computation	5
3	A Comparison of Means For The Metropolitan Achievement Test: Mathematical Concepts	6
4	A Comparison of School and College Ability Test	9
5	A Comparison of Cooperative English Test	10
6	A Comparison of Stanford Numerical Competence and Mathematics A Tests	11
7	A Comparison of Selected Percentiles For School and College Ability Test	13
8	A Comparison of Selected Percentiles for Cooperative English Test	14
9	A Comparison of Selected Percentiles For Stanford Numerical Competence And Mathematics A Tests	15
10	A Comparison of Selected Percentiles For 10th Grade Testing Program: Entire State	16

List of Normal Percentile Charts

Chart Title Page

I SCAT Verbal....................................17

II SCAT Quantitative..............................18

III SCAT Total.....................................19

IV Reading Vocabulary.............................20

V Reading Level...................................21

VI Reading Speed..................................22

VII Reading Total.................................23

VIII English Expression...........................24

IX Numerical Competence...........................25

X Mathematics A...................................26

In the fall of 1965 the Bureau of Educational Research and Testing Services at the University of New Hampshire conducted the eighth consecutive yearly statewide testing program at grade eight for the New Hampshire State Department of Education. The program consisted of a mental abilities test, the Otis form Fm and the Metropolitan Achievement Test, battery form Am.

The research reported in this paper was conducted with the sponsorship of the New Hampshire State Department of Education and a grant from the United States Office of Education, Grant No. OEG-1-9-090023-0106(010). The purpose of the research was to evaluate empirically the effects of using different mathematics text books on the mathematical computational ability of students as a method of assessing the effectiveness of different mathematics instruction, based primarily on a text.

For about a year previous to 1965 there had been a growing level of concern about dropping mathematics computation scores as measured by the Metropolitan Achievement Test. In his 1964 report, Dr. Walter Durost said:

> "It is suspected that the adoption of the new curriculum in mathematics in New Hampshire may have resulted in the drop in Arithmetic Computation. This influence has been noted in other studies in communities where data are available over a period of years and where the new curriculum has recently been introduced."[1] (Durost, 1964)

In 1965 the total number of students tested in the state was 4,724. Of this number, 4,182 were included in the study. The eighth grade classes which participated in this voluntary statewide testing program were placed in one of four categories which were designated as follows: modern, traditional, transitional and other. 5 42 students were eliminated from the study by being placed in the category called other. Placement in these groups was done primarily on the basis of the text the school system had been using for three years previous to the 1965 eighth grade year. In other words, the texts the student used in grades 5,6 and 7 were identified as being either traditional, transitional or modern. The assignment of the texts and the school systems into one of these four groups was done by Mr. Fernand Prevost, Director of Mathematics Education, New Hampshire State Department of Education. This classification is, at best, a very subjective one but the following have been used as working definitions for this study of modern, traditional and transitional mathematics:

Working Definitions for Classifying Schools Based on Texts

If the mathematics text used by the school showed no deviation from methods of presentation common in the late 1950's or early 1960's, and introduced a minimal amount of new math, it was judged to be traditional. Such texts were more frequently filled with long exercise sections; little structure or rationale in concept development was emphasized.

> Texts which tended to approximate the California strand development were judged to be modern. Such texts placed stress on the development of concepts and concrete manipulations. Texts emphasizing mathematical systems, properties, functions and graphing, for example, met the criteria for modern.
>
> Those texts which the publisher had admitted, or which Mr. Prevost judged, to have a middle of the road approach were considered transitional. These texts were somewhere along the continuum of traditional to modern.
>
> Where a school system did not fit into a category it was eliminated from the study.

Using the raw scores on the Otis-Gamma intelligence test, a one-way analysis of variance was computed looking for differences among these three groups. (Ferguson, 1959). This analysis indicated there was a significant difference among the mean raw scores for these three groups. The computed F was 14.81 which is significant beyond the .01 level. Following the analysis of variance, T tests were run among the three groups on their intelligence scores. The results of this analysis indicated there was a significant difference in intelligence beyond the .01 level between students in the modern mathematics group and those in the traditional mathematics group, favoring the modern group. It was found that there was a significant difference at the .01 level between those students studying modern mathematics and those studying transitional mathematics, again favoring the modern group. It was found there was a significant difference at the .05 level between those students studying traditional mathematics and those studying transitional mathematics, favoring the transitional group. The means, as well as the computed F's and T's, are given in Table 1.

The same procedure was followed in looking for significant differences among the three groups in the area of mathematics, as measured by the Metropolitan Achievement Test, using the Computation and Concepts subtests of the battery. The analysis of the Computation scores on the Metropolitan Achievement Test indicated there was a significant difference among the mean computational abilities for the three groups. The computed F was 6.87 which is significant beyond the .01 level. Following the analysis of variance, T tests were run between the three groups on their computation scores. There was a significant difference between the modern mathematics group and the traditional group which was significant at the .01 level. There was a significant difference between the modern mathematics students and the transitional students at the .05 level. There was a significant difference between the traditional students and the transitional students which was significant at the .05 level. The means as well as the computed F's and T's are given in Table 2.

The data from the Metropolitan Achievement Test, subtest Mathematical Concepts, was also analyzed but no significant difference was found among the three groups. The reported F is .99. The means as well as the computed F are given in Table 3.

The results of these two analyses indicate that there was a significant difference among the three groups based on their IQ. The difference favored the students studying modern mathematics, followed by those studying transitional mathematics, followed by those studying traditional mathematics. When one looks at the differences in computational ability one finds here, too, there is a significant difference, only in reverse. The students who have studied traditional mathematics did significantly better than those who studied transitional mathematics and those who studied modern mathematics. Those who studied transitional mathematics did better than those who studied modern mathematics.

Table 1

A COMPARISON OF MEANS FOR THE OTIS QUICK-SCORING MENTAL ABILITIES TEST: GAMMA

Fall 1965

	MODERN	TRADITIONAL	TRANSITIONAL
Number of Students	1215	591	2376
OTIS Means	36.69	33.59	34.70

Analysis of Variance

F = 14.81

.01 level of significance 4.60

T Tests	Modern : Trad.	Modern : Trans.	Traditional : Transitional
	4.96	4.27	2.15
Significant	.01	.01	.05

Table 2

A COMPARISON OF MEANS FOR THE METROPOLITAN ACHIEVEMENT TEST: COMPUTATION

Fall 1965

	MODERN	TRADITIONAL	TRANSITIONAL
Number of Students	1215	591	2376
COMPUTATION Means	28.56	30.08	29.22

Analysis of Variance

F = 6.87

.01 level of significance 4.60

T Tests	Modern : Trad.	Modern : Trans.	Traditional : Transitional
	3.65	2.26	2.26
Significant	.01	.05	.05

Table 3

A COMPARISON OF MEANS FOR THE METROPOLITAN ACHIEVEMENT TEST: MATHEMATICAL CONCEPTS

Fall 1965

	MODERN	TRADITIONAL	TRANSITIONAL
Number of Students	1215	591	2376
MATHEMATICAL CONCEPTS Means	29.17	29.34	28.87

Analysis of Variance

F = .99

Not Significant

In the fall of 1967 when these same students were now in 10th grade they were involved in another statewide testing program. In 1967, 9,776 10th graders participated in the statewide testing program. Of this number, 3,439 students were involved in the follow-up study. It should be noted that traditionally many more school systems participated in the 10th grade testing program than in the 8th and this accounts for the large discrepancy. It should also be noted that due to population loss and the difficulty of classifying high schools there was a loss of students between the original 8th grade population and the 10th grade population.

The 10th grade battery consisted of the School and College Ability Test, Form 2B; the Cooperative English Test, Form 2C; the Stanford High School Numerical Competence Test, Form X; the Stanford High School Mathematics Test, Form X, Part A and B. It was decided to use the same procedures as had been used two years earlier, when the students were in the 8th grade, to conduct the study.

Having divided the children into three groups, again classified as modern, traditional and transitional, the following analyses were conducted: a complete analysis of variance was done across the three groups using the School and College Ability Test, the Cooperative English Test, the Stanford Numerical Competence Test and the Stanford High School Mathematics Test, Part A and B. The following are the results of those computations.

There was a significant difference among the three groups as measured by the Verbal portion of the School and College Ability Test; F = 9.6. There was no significant difference among the three groups as measured by the School and College Ability Test, Quantitative; F = 1.5. There was no significant difference among the three groups as measured by the School and College Ability Test, Total: F = 2.39. Following this analysis a series of T tests was conducted and it was found there was a significant difference on Verbal skills between modern and traditional groups and the modern and transitional groups. There was a non-significant difference between the traditional and the transitional group. The means as well as the computed F's and T's are given in Table 4.

There was a significant difference among the three groups as measured by the Vocabulary portion of the Cooperative English Test; F = 5.132. There was no significant difference in Reading Level; F = 2.94. There was no significant difference in Reading Speed; F = 2.10. There was a significant difference among the three groups in terms of English Expression; F = 5.57. Following this analysis, a series of T tests was conducted and it was found that on Reading Vocabulary there was a significant difference between modern and traditional groups and the modern and transitional groups. There was no significant difference between the traditional group and the transitional group. There was no significant difference among the three groups on Reading Level and Reading Speed.

On Reading Total there was a significant difference between the modern and traditional group and between the modern and transitional group. There was a non-significant difference between the traditional and the transitional group. On English Expression, there was a significant difference between the modern and the traditional group, and the modern and transitional group. There was a non-significant difference between the traditional and transitional group. The means as well as the computed F's and T's are given in Table 5.

An analysis of variance based on Numerical Competence was computed and it was found there was a non-significant difference. There was a very significant difference at the .01 level with an F of 19.58 for Mathematics subtest A of the Stanford. We find here that there is a significant difference between the modern and traditional group, a non-significant difference between modern and transitional and again a significant difference between transitional and traditional. The means as well as the computed F's and T's are given in Table 6.

Table 4

A COMPARISON OF SCHOOL AND COLLEGE ABILITY TEST

Fall 1967

	SCAT Verbal		SCAT Quantitative		SCAT Total	
Modern Mean Group 1	31.87		28.60		60.46	
Traditional Mean Group 2	29.23		28.93		58.16	
Transitional Mean Group 3	30.36		29.18		59.48	
F's	9.560		1.488		2.385	
Significant	.01		NS		NS	
T's and Significance						
1 : 2 =	3.888	.01	0.641	NS	2.110	NS
1 : 3 =	3.427	.01	1.722	NS	1.393	NS
2 : 3 =	1.771	NS	0.505	NS	1.282	NS

Table 5

A COMPARISON OF COOPERATIVE ENGLISH TEST

Fall 1967

	Reading Vocab	Reading Level	Reading Speed	Reading Total	English Expression
Modern Mean Group 1	35.54	18.56	29.44	64.79	45.08
Traditional Mean Group 2	34.04	18.22	28.47	62.50	42.88
Transitional Mean Group 3	34.51	18.07	28.69	63.13	44.04
F's	5.132	2.937	2.102	3.240	5.571
Significant	.01	NS	NS	.05	.01
T's and Significance					
1 : 2 =	2.614 .01	1.093 NS	1.569 NS	2.011 .05	3.160 .01
1 : 3 =	2.766 .01	2.426 NS	1.852 NS	2.254 .05	2.300 .05
2 : 3 =	0.870 NS	0.514 NS	0.388 NS	0.582 NS	1.770 NS

Table 6

A COMPARISON OF STANFORD NUMERICAL COMPETENCE AND MATHEMATICS A TESTS

Fall 1967

	Numerical Competence		Mathematics A	
Modern Mean Group 1	27.04		26.09	
Traditional Mean Group 2	26.51		19.41	
Transitional Mean Group 3	26.59		25.68	
F's	1.047		19.578	
Significant	NS		.01	
T's and Significance				
1 : 2 =	1.068	NS	6.157	.01
1 : 3 =	1.351	NS	0.783	NS
2 : 3 =	0.183	NS	5.934	.01

In the mathematical development of the analysis of variance, a number of assumptions are made. One assumption is that the distribution of variables and the population from which the samples are drawn are normal. Since this study is not based upon the drawing of a sample from a population, but is, in fact, a population itself, the use of analysis of variance can seriously be questioned. Because of the failure to meet this requirement, the project director, in consultation with other statisticians, decided that to pursue the project as originally proposed, the analysis of co-variance for the 1967 study would be inappropriate, since the assumptions for simple analysis are not met. The assumptions are certainly not met for the analysis of co-variance; therefore, it was decided that the 1967 grade 10 data would be subjected to further analysis by computing selected percentile ranks as a basis for determining differential effects for above and below average students.

Five selected percentile ranks were chosen for this study: they are the 90th, 75th, 50th, 25th, and 10th. The comparisons that are provided indicate the raw scores at these selected percentiles for the students involved in the study, taking the test at grade 10 (3,439 students). We have also prepared normal percentile charts which visually present the same information. Shown are the raw scores for the modern group which numbered 1,107 students; for the traditional group, which numbered 404 students; and for the transitional group, which numbered 1,928 students. These comparisons, as well as comparisons for the entire state, may be studied in Tables 7-10 and normal percentile charts I - X.

The modern mathematics group on SCAT Verbal seems to do markedly better than either of its two comparable groups at the 50th, 75th and 90th percentiles. On the Quantitative subtest there seems to be little difference at the upper percentile levels between the three groups but there does seem to be some degree of difference at the 25th and 10th percentiles favoring the traditional and transitional groups. A similar pattern can be noted on SCAT total as well as on many of the Cooperative English Tests. A similar pattern can be noted also on the Stanford Numerical Competence subtest. On the High School Mathematics Test, Part A, we seem to find a very real and important difference favoring the students studying modern mathematics over those studying traditional mathematics. At the upper selected percentile ranks these differences run between 7 and 8 raw score points, while at the lower selected percentiles the difference is between 5 and 7 points. The transitional group again seems to fall between the two groups at the upper selected percentiles, but exceeds both at the lower selected percentiles.

Table 7

A COMPARISON OF SELECTED PERCENTILES FOR SCHOOL AND COLLEGE ABILITY TEST

Fall 1967

NAME OF TEST	SELECTED PERCENTILES IN RAW SCORES				
	10th	25th	50th	75th	90th
SCAT Verbal					
Modern Group	15	21	31	41	49
Traditional Group	16	21	28	36	44
Transitional Group	16	21	29	38	47
SCAT Quantitative					
Modern Group	15	22	29	35	40
Traditional Group	17	23	29	35	39
Transitional Group	17	23	29	35	40
SCAT Total					
Modern Group	34	45	60	75	86
Traditional Group	36	45	58	69	81
Transitional Group	35	45	59	73	84

Table 8

A COMPARISON OF SELECTED PERCENTILES FOR COOPERATIVE ENGLISH TEST

Fall 1967

NAME OF TEST	SELECTED PERCENTILES IN RAW SCORES				
	10th	25th	50th	75th	90th
Reading Vocabulary					
Modern Group	21	28	35	43	49
Traditional Group	23	28	33	39	46
Transitional Group	22	27	34	41	47
Reading Level					
Modern Group	10	14	19	22	25
Traditional Group	11	14	18	21	24
Transitional Group	10	14	18	22	24
Reading Speed					
Modern Group	15	20	29	37	44
Traditional Group	16	20	28	35	42
Transitional Group	15	20	28	36	43
Reading Total					
Modern Group	38	48	65	80	92
Traditional Group	41	48	61	74	86
Transitional Group	38	49	62	77	88
English Expression					
Modern Group	28	36	44	54	62
Traditional Group	28	35	42	50	57
Transitional Group	28	36	43	51	60

Table 9

A COMPARISON OF SELECTED PERCENTILES FOR STANFORD NUMERICAL COMPETENCE AND MATHEMATICS A TESTS

Fall 1967

NAME OF TEST	SELECTED PERCENTILES IN RAW SCORES				
	10th	25th	50th	75th	90th
Numerical Competence					
Modern Group	14	20	27	33	38
Traditional Group	16	21	27	32	36
Transitional Group	15	20	27	33	37
Mathematics A					
Modern Group	17	21	26	30	34
Traditional Group	12	14	19	23	26
Transitional Group	18	22	25	29	33

Table 10

A COMPARISON OF SELECTED PERCENTILES FOR 10TH GRADE TESTING PROGRAM: ENTIRE STATE

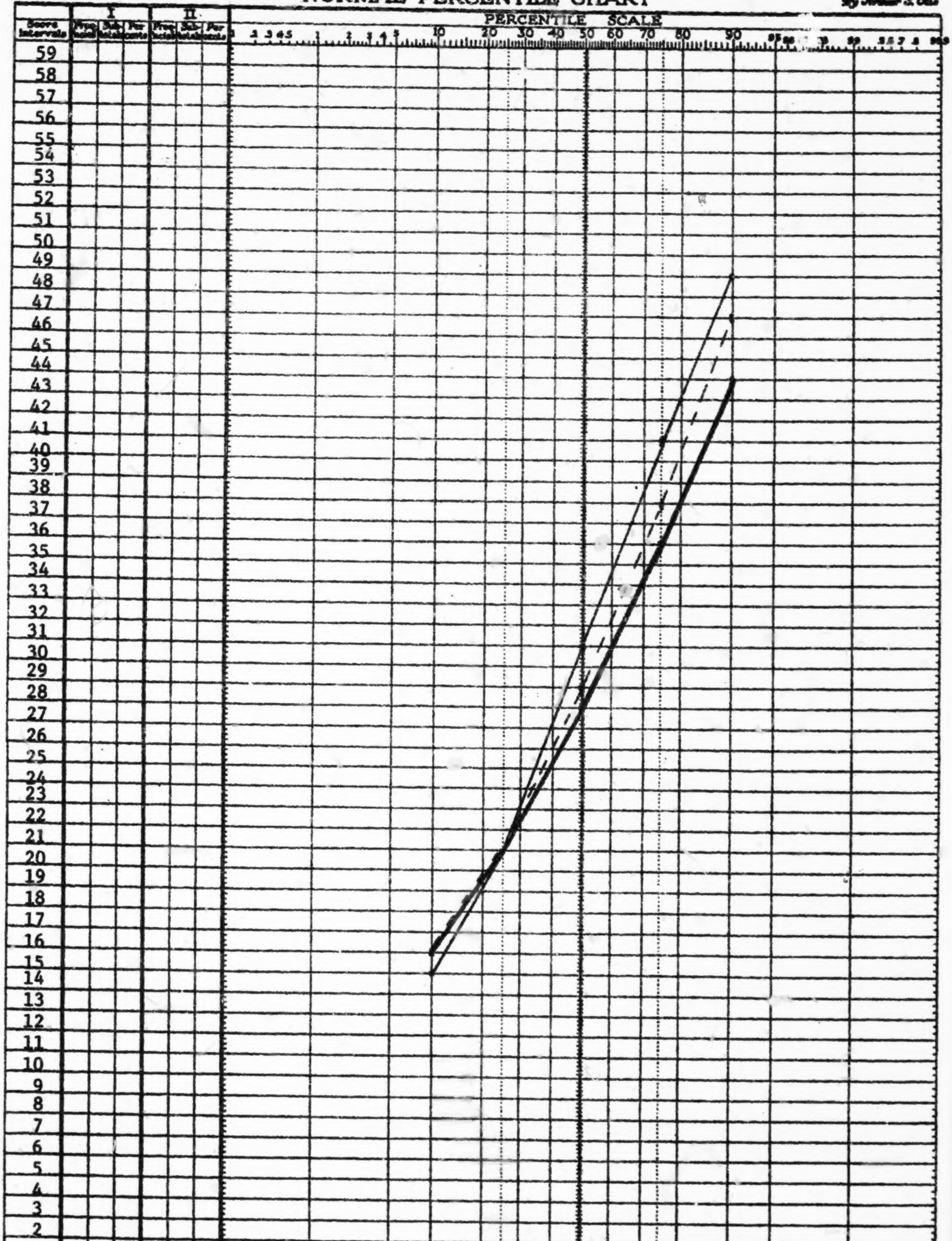
Fall 1967

NAME OF TEST	SELECTED PERCENTILES IN RAW SCORES				
	10th	25th	50th	75th	90th
SCAT Verbal	16	21	29	39	47
SCAT Quantitative	16	21	29	35	47
SCAT Total	34	45	58	72	84
Reading Vocabulary	22	28	35	41	47
Reading Level	10	14	18	22	25
Reading Speed	15	20	28	36	43
Reading Total	38	49	64	77	89
English Expression	28	35	43	52	59
Numerical Competence	14	20	26	32	37
Mathematics A	16	21	26	31	34

SCAT VERBAL GRADE10 MATH STUDY CHART I FALL '67

NORMAL PERCENTILE CHART

By Arthur S. Otis

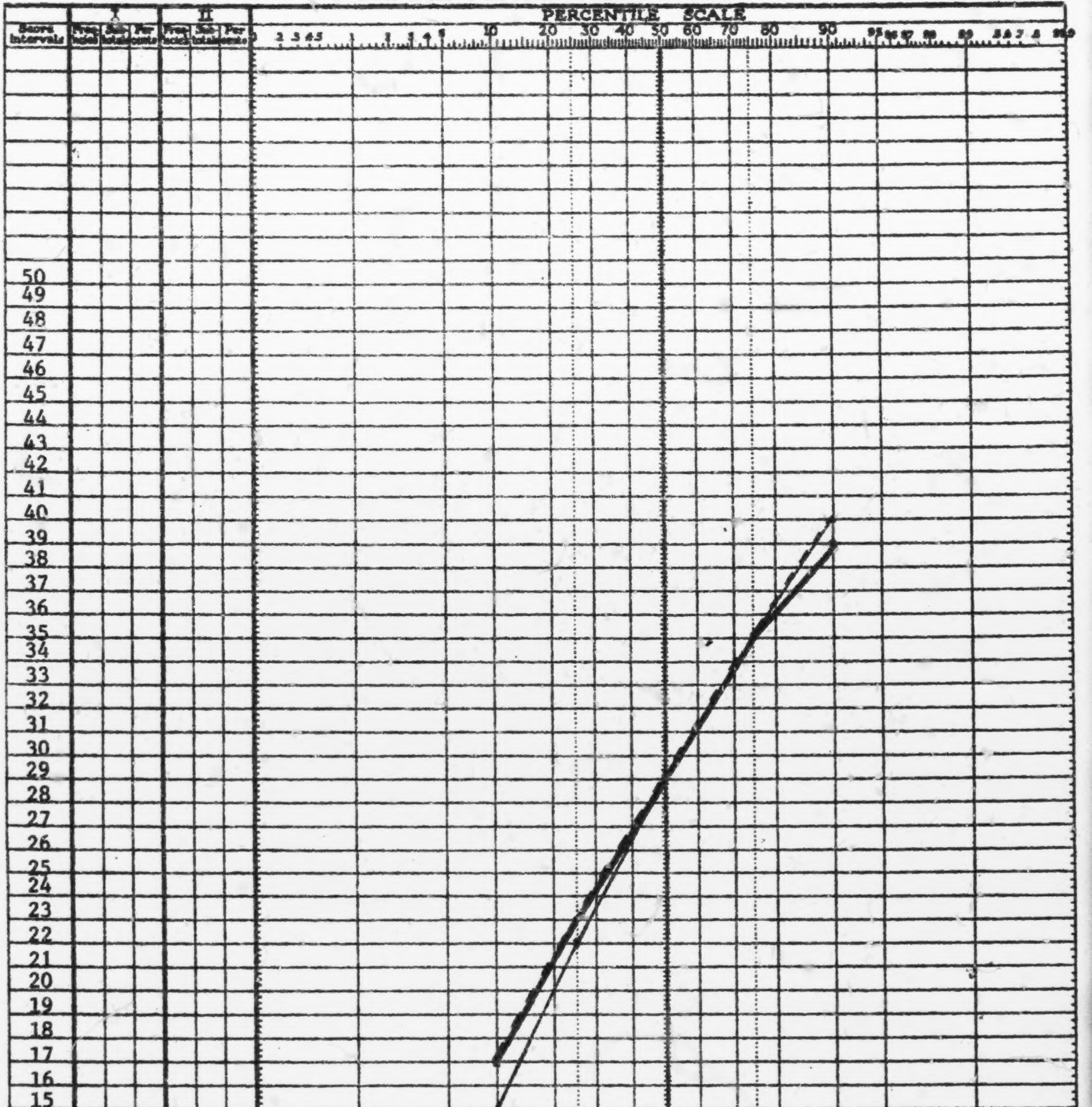


KEY: ---TRAN., ▬TRAD., ___MODERN

SCAT QUANTITATIVE, GRADE 10 MATH STUDY CHART II FALL '67

NORMAL PERCENTILE CHART

By Arthur S. Otis

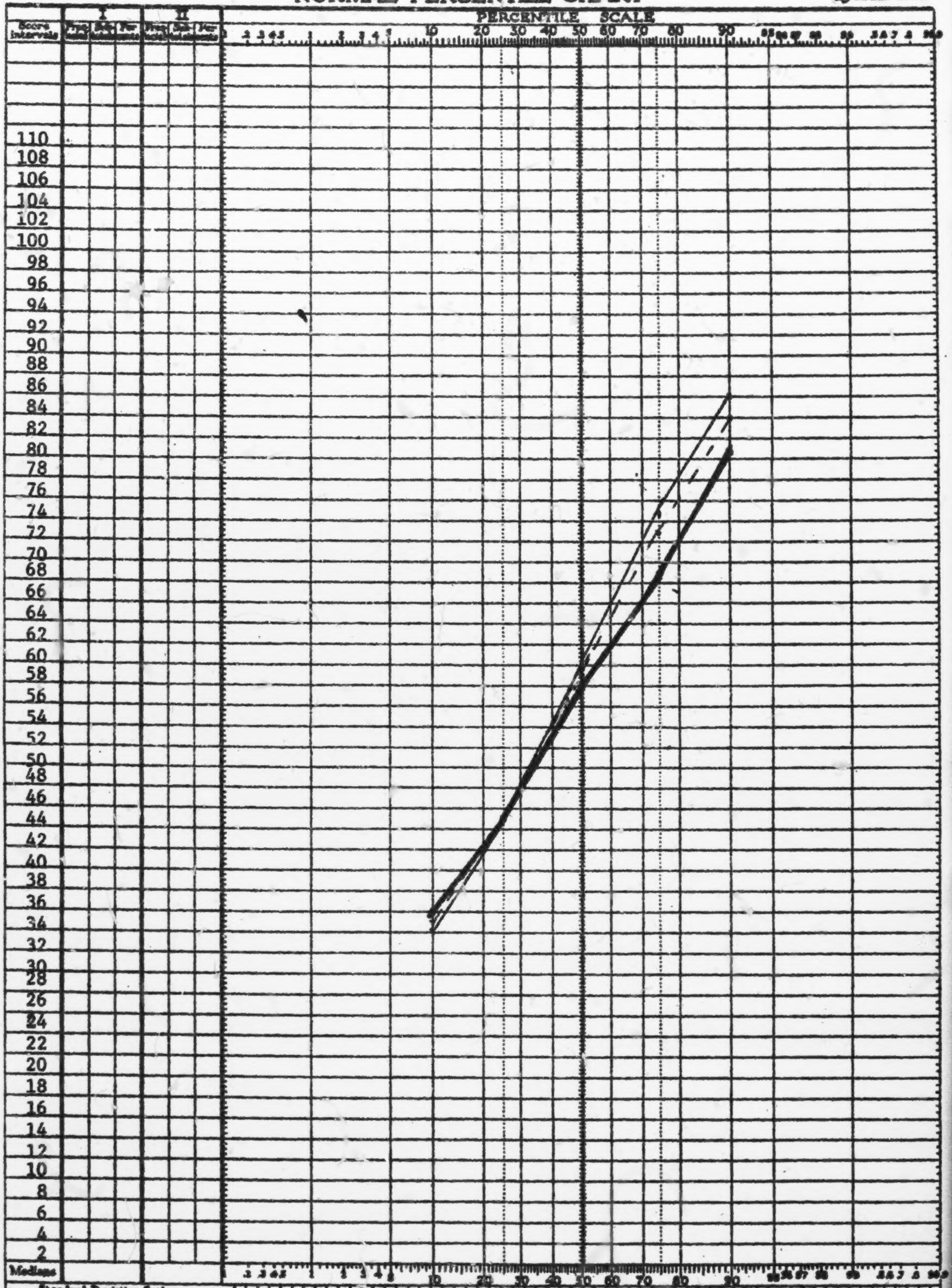


KEY: ---Tran, ■Trad., ___ Modern.

SCAT TOTAL GRADE 10 MATH STUDY CHART III FALL '67

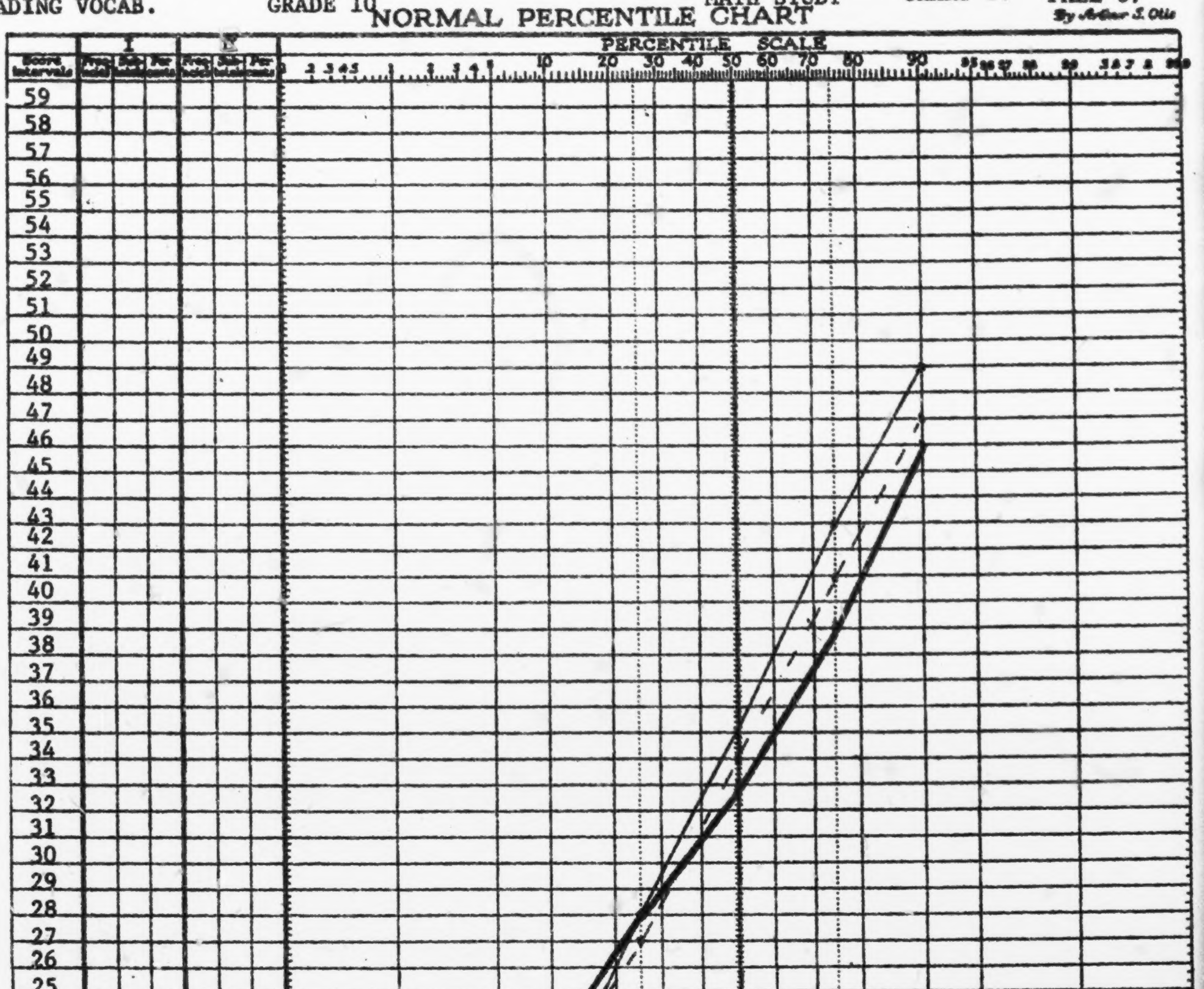
NORMAL PERCENTILE CHART

By Arthur S. Otis



Key: ----Tran., ▬ Trad., ___ Modern

READING VOCAB. GRADE 10 MATH STUDY CHART IV FALL'67

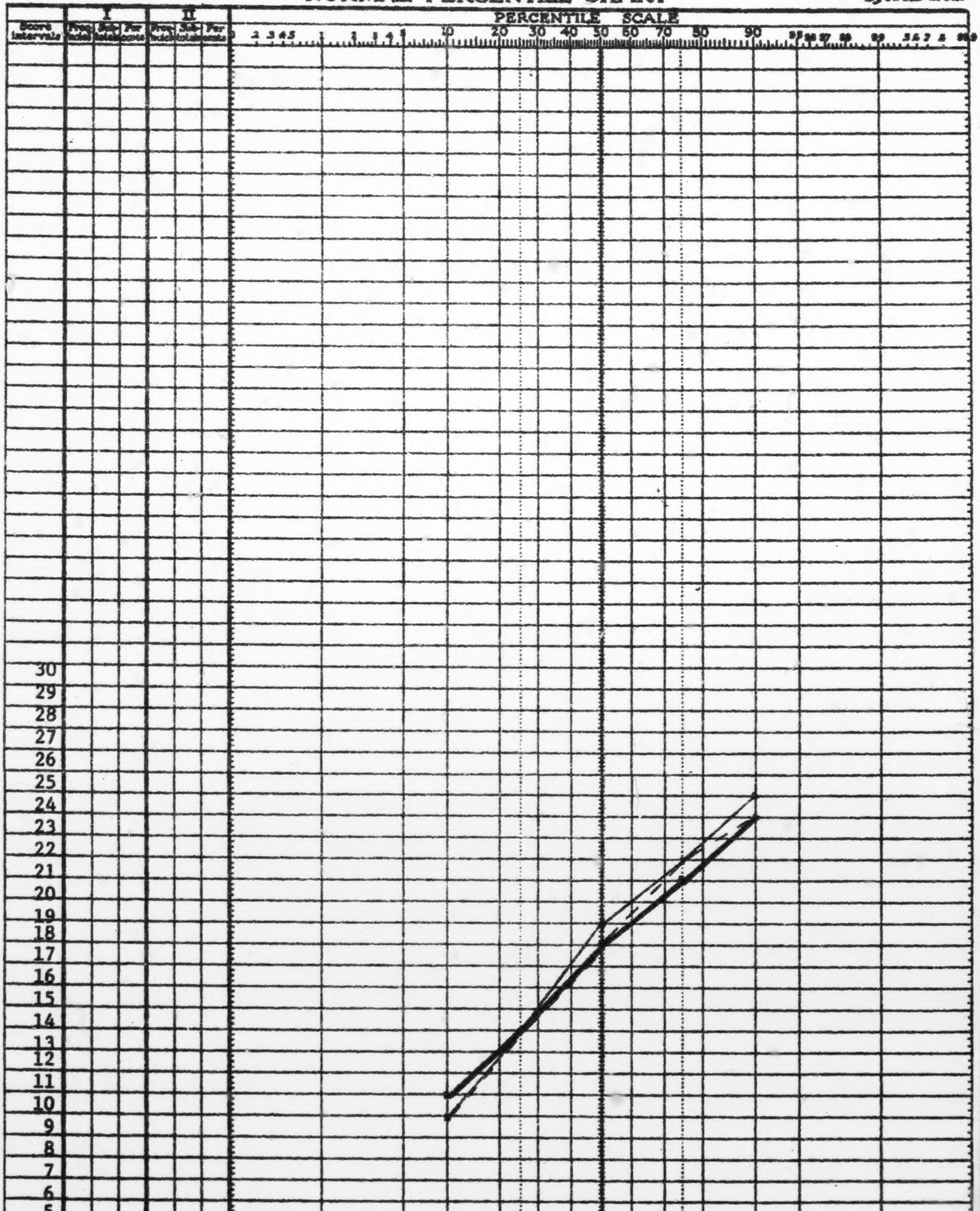


KEY: —TRANSITIONAL, ▬TRADITIONAL, ___MODERN

READING LEVEL GRADE 10 MATH STUDY CHART V FALL'67

NORMAL PERCENTILE CHART

By Arthur S. Otis

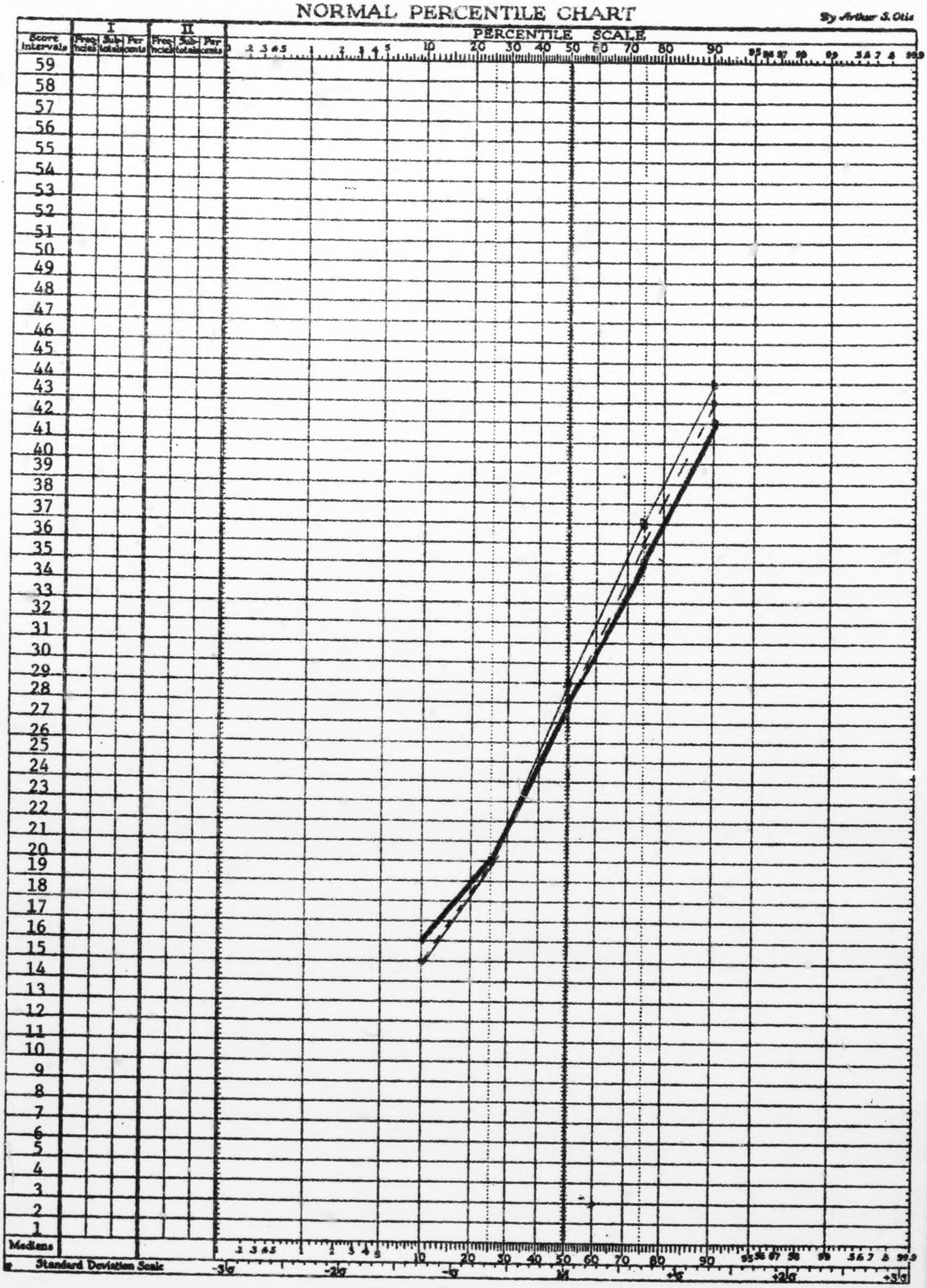


KEY: ----TRAN., ▬ TRAD., ___ MODERN

READING SPEED GRADE 10 MATH STUDY CHART VI FALL '67

NORMAL PERCENTILE CHART

By Arthur S. Otis

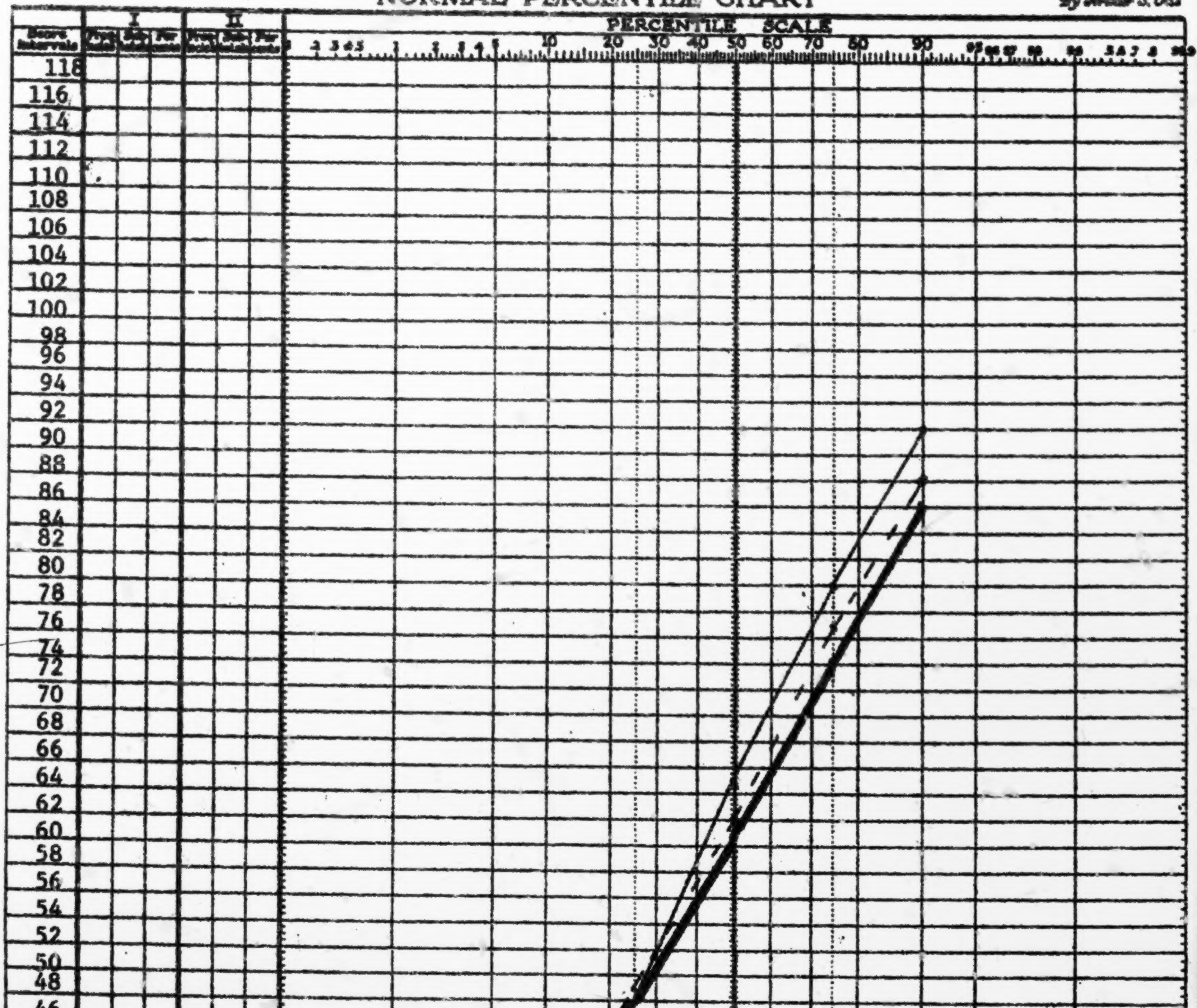


KEY: --- TRANSITIONAL, ▬ TRADITIONAL, ___ MODERN

READING TOTAL GRADE 10 MATH STUDY CHART VII FALL "67

NORMAL PERCENTILE CHART

By Arthur S. Otis

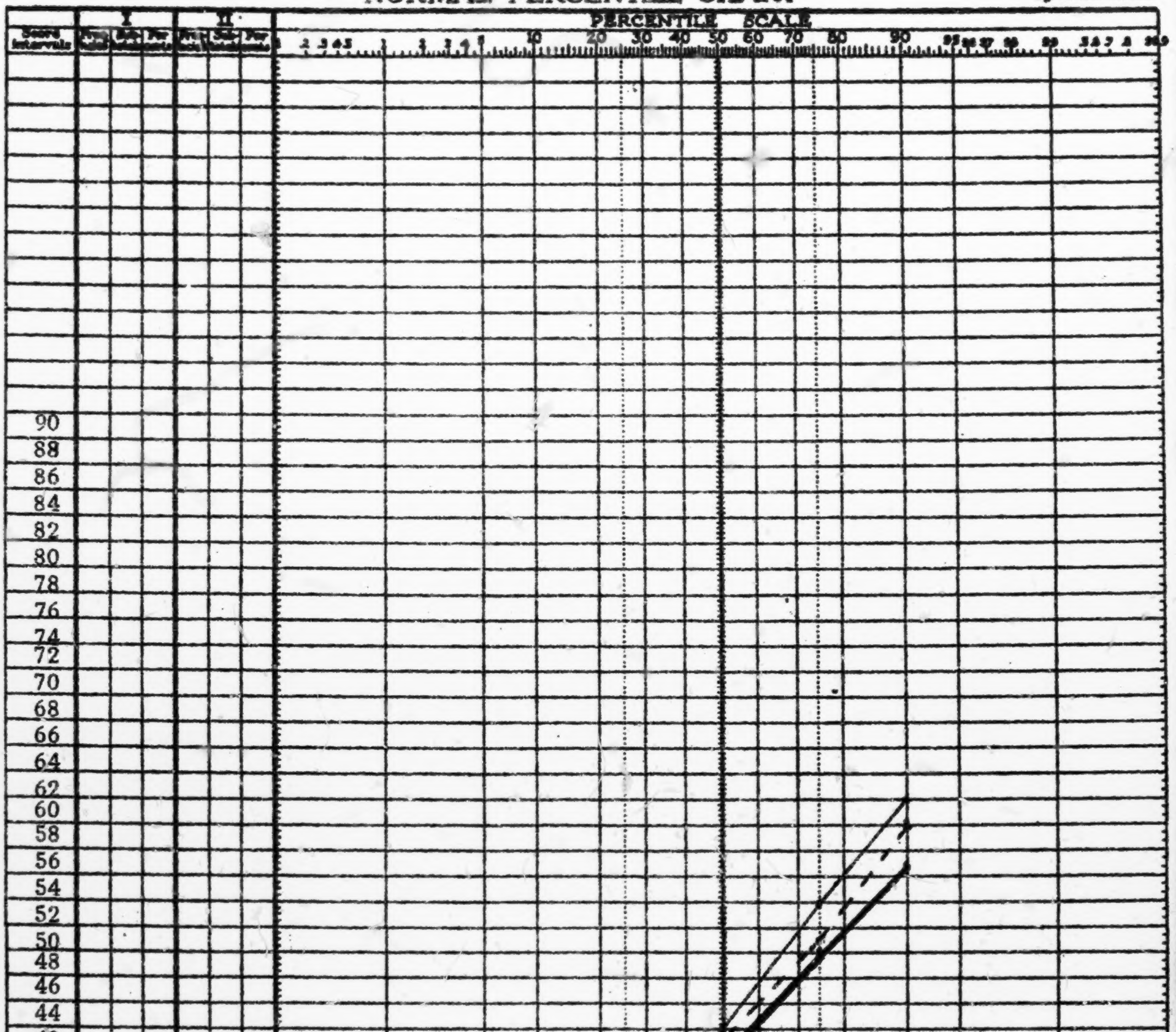


KEY: ___ TRAD., ___ MODERN

ENGLISH EXPRESSION GRADE 10 MATH STUDY CHART VIII Fall '67

NORMAL PERCENTILE CHART

By Arthur S. Otis

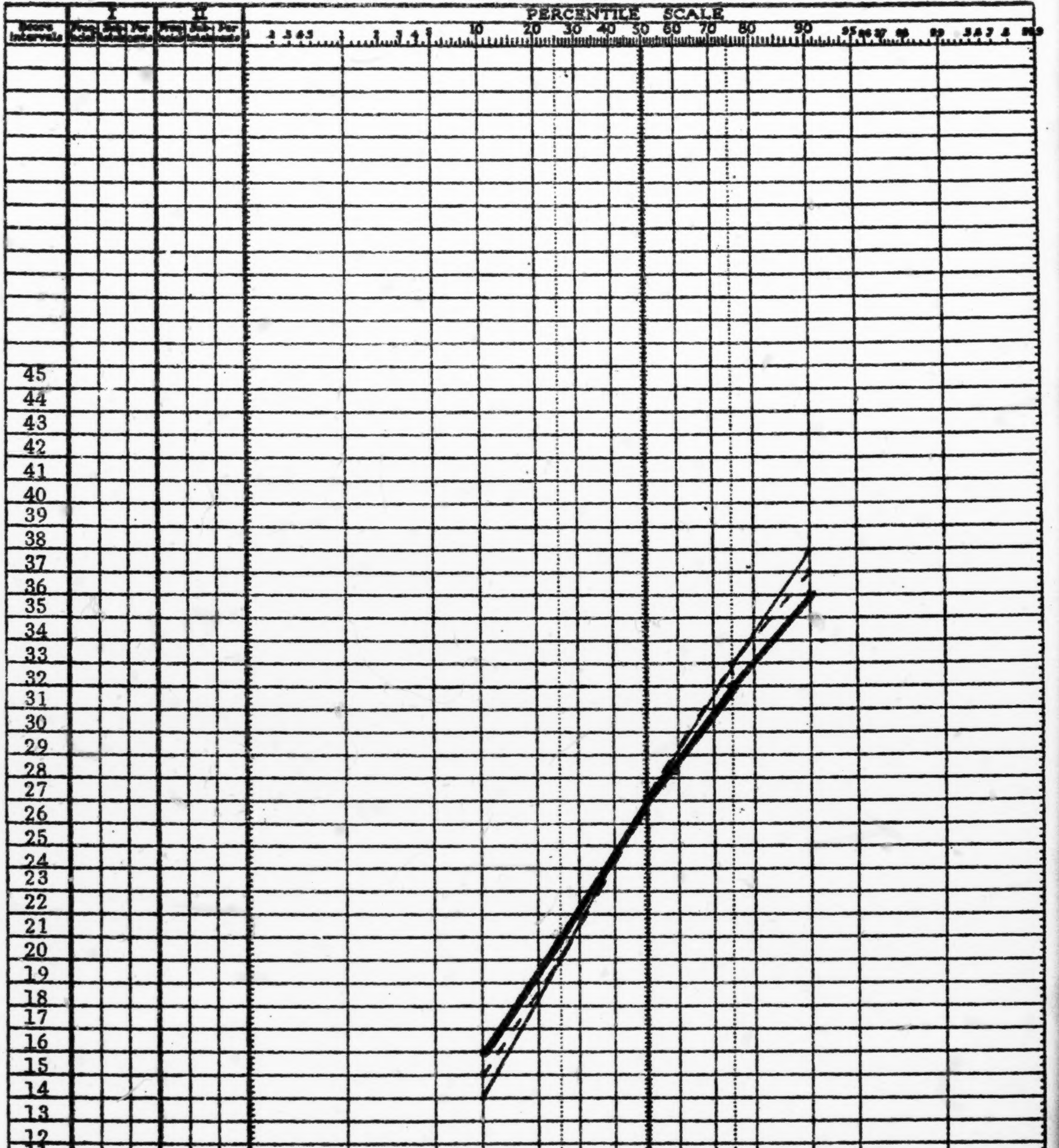


KEY: ----TRAN., ▬ TRAD., MODERN____

NUMERICAL COMP. GRADE 10 MATH STUDY CHART IX FALL '67

NORMAL PERCENTILE CHART

By Arthur S. Otis

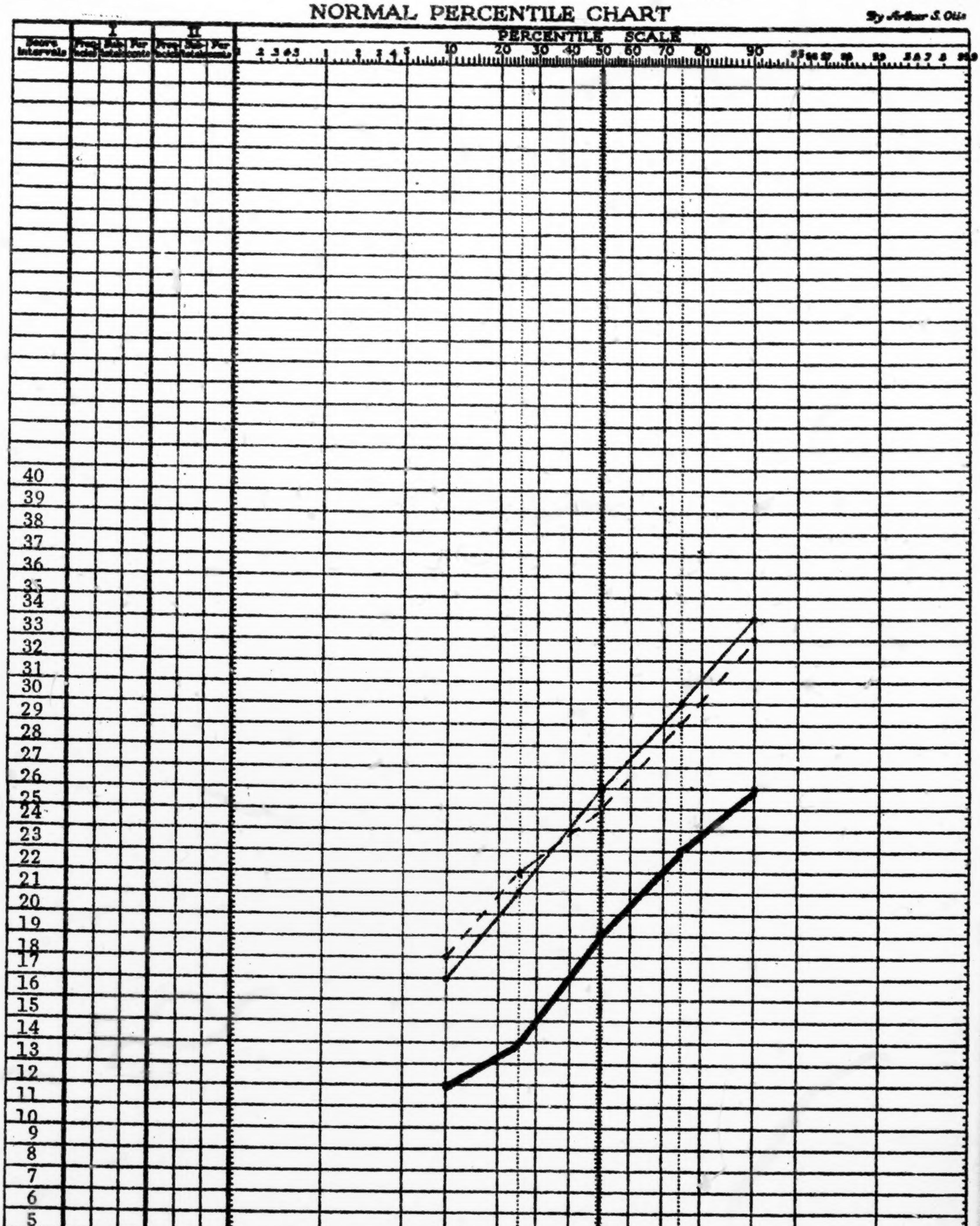


KEY: ——TRAN., ▬TRAD., ——— MODERN

MATHEMATICS A GRADE 10 MATH STUDY CHART X FALL '67

NORMAL PERCENTILE CHART

By Arthur S. Otis



KEY: ----TRAN., ▬ TRAD., ____ MODERN

Conclusions

Using the statewide grade 8 test data it became apparent in 1964 that there had been a significant drop in arithmetic computation scores since 1963. It was hypothesized that modern mathematics was contributing to this decline in computational ability. As a result of that hypothesis a study was conducted which we have already discussed at length. This study clearly indicated that students in the modern mathematics group were intellectually superior to those in the traditional or transitional group, while just the inverse was true in terms of their ability to do arithmetic computation. It should be noted here that one of the abvious weaknesses and problems associated with this study is, what is meant by the terms modern, traditional and transitional. These terms are not easily defined, but we have earlier presented Mr. Prevost's working definition of these terms.

The same study was replicated when the former eighth grade students were in the tenth grade. It is noted, again as one of the problems in the second study, that there were rather different degrees of student-loss between grade 8 and grade 10. There was a 9% loss for the modern group; a 32% loss for the traditional group and a 19% loss for the students in the transitional group. A number of hypotheses seem to explain this.

It is more likely that traditional students were classified or were found in small eighth grade systems which sent their students to high schools in another town for their high school education and that some of these high schools had to be eliminated from the study because the tenth graders in them were not all from schools that had been classified formerly as traditional, transitional or modern. The fact is possible for all three groups but more likely to have happened, in the author's opinion, with the traditional and transitional students. Since the students classified as modern tended to come from the more affluent communities, they tended to have their own high schools.

There is a second possible reason for the very significantly different student loss and that is that the traditional group again may be coming from smaller or rural communities whose students tend to stay in school a shorter period of time. This is somewhat less true for the transitional and the modern group.

A third possible reason is that the students who are classified as traditional found school, and its traditional orientation, not responsive to their particular needs and therefore were disappointed, and alienated from, the school at an earlier period since the school was doing little to sustain their interests in staying in school. This would account for the higher student loss. Whether or not this student loss affected the statistics reported for the tenth graders is not easily answered.

The results of the tenth grade study have already been reported in detail. It seems clear from those results that for the School and College Ability Test, the Verbal section is probably the truest indicator of mental abilities and that there still is a significant difference between these three populations at grade 10 in terms of their intellectual prowess. This hypothesis is supported by the fact that there is a significant difference in English Vocabulary, Reading Total and English Expression in the same direction favoring the modern group. At the very least one could say that the students in the modern group are, in terms of their Verbal skills, significantly different from the students in the traditional and transitional groups. The order in all cases shows the modern group highest, transitional second and the traditional, third. This is the pattern which has continued for the three years of this study. In terms of arithmetic abilities, particularly arithmetic computation, it is no longer true at grade ten that there are significant differences between these three groups. This is verified twice, once in the Quantitative portion of the SCAT and secondly, as part of the Stanford Numerical Competence Test. In either case there is no significnat difference between the three groups. What this seems to clearly say is that while the students classified as modern have, at grade 8, less ability at arithmetic computation, apparently the two years of practice (grade 8, grade 9 and part of grade 10) cause them to increase their skills to the point where there are no longer any significant differences between the three groups.

It is particularly interesting to look at the Stanford High School Mathematics Test, Part A, results, in which we find a very significant F of 19.57, and to look at the means for the three groups, which are: modern group--26.09; transitional group--25.68; and traditional group--19.41. There are no significant differences between the modern and the transitional group but there are very significant differences between the transitional group and the traditional group and the modern group and the traditional group. I think it is worthy of note here that this difference not only seems to be statistically significant, but perhaps more important, educationally significant. It is beyond the scope of this present paper to make an analysis of what is causing that particular very significant difference but it is something that the author is presently engaged in researching. But it is easily hypothesized that the students in modern mathematics, when asked to work in the area of algebra and geometry, which is what this test measures, do markedly better than do their traditional counterparts. I think it is safe to say that algebra and geometry call for many more verbal skills than they do pure computational skills and it is here, apparently, that the greatest pay-off comes for the students who have studied modern mathematics.

One of the questions that needs to be raised relative to this piece of research is: how representative has the performance in mathematics of these eighth and tenth graders been to the entire eighth or tenth grade population in the state of New Hampshire? If one makes the comparison between Tables 7, 8 and 9, which present the raw scores obtained by the three 10th grade groups, at five selected percentiles, with Table 10, which is the same information for the entire state, one finds, particularly at the medians, that there are not many serious discrepancies between any two of the groups. The author believes it is safe to say that there is at least as much variance within the three groups as there is variance between any one of the groups and the entire state. It therefore is the author's conclusion that these groups are in fact a representative sample of the entire state and not a special or unique sub-set of that population. These conclusions can only be reached for grade 10 because no such comparison was made on the eighth grade data in 1965.

Tables 7, 8 and 9 offer some additional interesting possibilities for study. It was noted in the body of the report that the students classified as the modern group seemed to do quite well in computation if they were found in the upper end of the spectrum in terms of the selected percentiles, i.e. the 75th or 90th percentile. Students classified as modern tended to do more poorly in computation if, in fact they were found at the bottom of that scale, i.e. the 10th and 25th percentiles. The reverse seemed to be true for students classified in the traditional group. The students at the bottom of the scale, i.e. the 10th and 25th percentile, seemed to do better than one would have expected and the students at the upper percentiles, i.e. the 75th or 90th, seemed to do more poorly than one would have expected. There are some interesting exceptions to this in the paper so that it can not be presented as a flat set of statements. But it holds generally to be true. I think this finding argues very cogently for the concept of differentiated instruction, particularly at different ability levels.

APPENDIX

Footnotes

[1] Durost, Walter N. Report and Summary. New Hampshire Statewide Grade Eight Testing Program. Concord, New Hampshire: Test Service and Advisement Center, November, 1964, p.9.

References

BOOKS

Ferguson, George A. Statistical Analysis in Psychology and Education. New York: McGraw-Hill, 1959.

REPORTS

Austin, Gilbert R. (ed.). New Hampshire Eighth Grade Testing Program. Report for school year 1967-1968, sponsored by the New Hampshire State Department of Education in cooperation with the Bureau of Educational Research and Testing Services. University of New Hampshire, 1967.

-----. (ed.). New Hampshire Eighth Grade Testing Program. Report for school year 1966-1967, sponsored by the New Hampshire State Department of Education in cooperation with the Bureau of Educational Research and Testing Services. University of New Hampshire, Fall, 1966.

-----. (ed.). New Hampshire Eighth Grade Testing Program. Report for school year 1965-1966, sponsored by the New Hampshire State Department of Education in cooperation with the Bureau of Educational Research and Testing Services. University of New Hampshire, November, 1965.

Durost, Walter N. (ed.). Report and Summary. New Hampshire Statewide Grade Eight Testing Program. Report prepared by the Test Service and Advisement Center, Concord, New Hampshire, November, 1964.

-----. (ed.). Report and Summary. New Hampshire Statewide Grade Eight Testing Program. Report prepared by the Test Service and Advisement Center, Concord, New Hampshire, November, 1963.

Dyer, Henry S., Linn, Robert L., and Patton, Michael J. Methods of Measuring School System Performance. Report to the New York State Education Department. Prepared by Educational Testing Service, Princeton, New Jersey, August, 1968.

Hogan, Thomas P. Some Notes on the Performance of Pupils in Modern and Traditional Mathematics Programs on Standardized Arithmetic Tests. Report prepared by Test Department, Harcourt, Brace and World.

References

OTHER SOURCES

Cooperative School and College Ability Tests. Princeton: Educational Testing Service, 1956-57.

Derrick, Clarence, Harris, David P. and Walker, Biron. Cooperative English Tests. Princeton: Educational Testing Service, 1960.

Durost, Walter N. (General Editor). Metropolitan Achievement Tests. High School Battery. New York: Harcourt, Brace and World, 1962.

Gardner, Eric F. et al. Stanford Achievement Test. New York: Harcourt, Brace and World, 1964.

-----. Stanford High School Mathematics Test. New York: Harcourt, Brace and World, 1964.

-----. Stanford High School Numerical Competence Test. New York: Harcourt, Brace and World, 1964.

Kelley, Truman L. et al. Stanford Achievement Test. Technical Supplement. New York: Harcourt, Brace and World, 1966.

Otis, Arthur. Otis Quick-Scoring Mental Ability Tests. New York: Harcourt, Brace and World, 1954.

A STUDY OF ABILITY AND ACHIEVEMENT IN MATHEMATICS OF THREE GROUPS OF TENTH GRADERS IN NEW HAMPSHIRE

List of Tables

Table Title Page

1 A Comparison of School and College Ability Test............ 4

2 A Comparison of Cooperative English Test................... 5

3 A Comparison of Stanford Numerical Competence and Mathematics A Tests...................................... 6

4 A Comparison of Selected Percentiles for School and College Ability Test..................................... 9

5 A Comparison of Selected Percentiles for Cooperative English Test..10

6 A Comparison of Selected Percentiles for Stanford Numerical Competence and Mathematics A Tests...............11

List of Normal Percentile Charts

Chart	Title	Page
I	SCAT Verbal	12
II	SCAT Quantitative	13
III	SCAT Total	14
IV	Reading Vocabulary	15
V	Reading Level	16
VI	Reading Speed	17
VII	Reading Total	18
VIII	English Expression	19
IX	Numerical Competence	20
X	Mathematics A	21

In the fall of 1967 the Bureau of Educational Research and Testing Services, acting as a contractual agent for the State Department of Education, conducted the annual 10th grade statewide testing program. This study concerns itself with the evaluation of the mathematical computational ability of a small subset within that much larger program. In 1967 there were 9,776 10th graders who participated in the statewide testing program. Of this number, 3,439 students were involved in a follow-up study comparing 8th grade computational ability with present 10th grade computational ability. Of the 3,439 students participating in the follow-up study, 620 students had elected to take the Stanford Mathematics Test, Part A, an optional test in the 10th grade battery which measures abilities in the area of algebra and geometry.

The 10th grade test battery consisted of the School and College Ability Test, Form 2B; the Cooperative English Test, Form 2C; the Stanford High School Numerical Competence Test, Form X; and the Stanford High School Mathematics Test, Form X, Part A and B. The Stanford Numerical Competence Test is recommended by the New Hampshire State Department of Education as a test which is appropriate to give all 10th graders in the state of New Hampshire. The Stanford Mathematics Test, Part A and Part B, is recommended by the State Department of Education as only suitable for those students who are involved in advanced mathematics courses in their school systems.

The original study in which these 620 students were involved was concerned with the question, does the type of text book that the teacher uses in the class make any difference in terms of the students' computational ability? The communities participating in that statewide program had been divided into three separate categories classified as modern, traditional and transitional, based on the type of textbook they were using. The working definitions of those classifications, as used in the original studies, are as follows:

Working Definitions for Classifying Schools Based on Texts

> If the mathematics text used by the school showed no deviation from methods of presentation common in the late 1950's or early 1960's, and introduced a minimal amount of new math, it was judged to be traditional. Such texts were more freqmently filled with long exercise sections; little structure or rationale in concept development was emphasized.
>
> Texts which tended to approximate the California strand development were judged to be modern. Such texts placed stress on the development of concepts and concrete manipulations. Texts emphasizing mathematical systems, properties, functions and graphing, for example, met the criteria for modern.
>
> Those texts which the publisher had admitted, or which Mr. Prevost judged, to have a middle of the road approach were considered transitional. These texts were somewhere

along the continuum of traditional to modern.

Where a school system did not fit into a category it was eliminated from the study.

In the original study of computational ability between 8th and 10th graders it was noted that there was a very large raw score difference in the means between those students that were classified as traditional, transitional or modern, on the Stanford High School Mathematics Test, Part A. The means being as follows: the modern group, 26.20; the traditional group, 19.68; and the transitional group as 25.93. This study is an attempt to see whether or not these differences were found only on the Stanford High School Mathematics Part A subtest or whether or not these difference were consistently found throughout the rest of the tests in this battery. In this present study the following numbers of students were in each group: in the modern group we had 226 students; in the traditional group we had 39 students; and in the transitional group we had 355 students.

The following analysis was conducted: a one-way analysis of variance, plus T tests, was done on 10 of the 11 tests in the 10th grade battery. The following are the results of those computations: on the School and College Ability Test the F's for the Verbal and the Total scores are both statistically significant and all the differences favor the modern group, secondly the transitional group and lastly, the traditional group. For the SCAT Quantitative the F is also statistically significant. There is only a statistically significant difference between the modern and the transitional group, favoring the transitional group. The means as well as the computed F's and T's are given in Table 1.

Following the analysis of the School and College Ability Test, a similar analysis was done on the Cooperative English Test. All of the computed F's are statistically significant at the 1% or 5% level, except English Expression on which there is a non-significant difference. All of the differences follow the pattern of results on the School and College Ability Test, Verbal and Total sections, with the modern group being the best, followed by the transitional group, followed by the traditional group. The means as well as the computed F's and T's are given in Table 2.

A similar analysis was conducted on the Stanford Numerical Competence Test and the Stanford Mathematics Test, Part A. On the Numerical Competence Test there is a significant F at the .01 level but the pattern has changed. Here the transitional group is performing markedly better than either the modern or the traditional group, a pattern similar to that noted on the School and College Ability Test, Quantitative section.

A similar analysis was conducted on the Stanford Mathematics Test, Part A. The computed F is significant at well beyond the .01 level. The study of the means of these three groups is worthy of our careful attention. The modern group and the transitional group do very well on this test, while the traditional group does very poorly. The means as well as the computed F's and T's are given in Table 3.

No computations or analysis were conducted on the Stanford Mathematics Part B test, because only students in the transitional and the modern groups took this test. No student in the traditional group elected to take Math B.

In the mathematical development of the analysis of variance, a number of assumptions are made. One assumption is that the distribution of variables and the population from which the samples are drawn are normal. Since this study is not based upon the drawing of a sample from a population, but is, in fact, a population itself, the use of analysis of variance can seriously be questioned. Because of the failure to meet this requirement, the project director, in consultation with other statisticians, decided that to pursue the project as originally proposed the analysis of co-variance for the 1967 study would be inappropriate, since the assumptions for simple analysis are not met. The assumptions are certainly not met for the analysis of co-variance; therefore, it was decided that the 1967 special sub-group data would be subjected to further analysis by computing selected percentile ranks as a basis for determining differential effects for above and below average students.

The test results of this special group were subjected to further analysis by computing selected percentile ranks as a basis for comparing the performance of above and below average students. Five selected percentile ranks were chosen for this study. They are: the 90th, 75th, 50th, 25th, and 10th. The comparisons provided indicate the raw scores at each of these selected percentile ranks for the students involved in the study. Table 4 presents this information for the School and College Ability Test; Table 5 for the Cooperative English Test; and Table 6 for the Stanford Numerical Competence Test and the Stanford Mathematics Test, Part A. The same information is presented graphically on Normal Percentile charts, I - X, which are found immediately following the selected percentiles. These Normal Percentile charts say, in graphical form, what the percentile tables say in tabular form.

Table 1

A COMPARISON OF SCHOOL AND COLLEGE ABILITY TEST

GRADE 10: Fall 1967

MATH A

	SCAT Verbal		SCAT Quantitative		SCAT Total	
Modern Mean Group 1	37.00		31.72		68.72	
Traditional Mean Group 2	30.21		32.21		62.42	
Transitional Mean Group 3	36.20		33.84		70.04	
F's	6.743		6.464		4.386	
Significant	.01		.01		.05	
T's and Significance						
1 : 2 =	3.666	.01	0.400	NS	2.357	.05
1 : 3 =	0.893	NS	3.530	.01	1.010	NS
2 : 3 =	3.319	.01	1.360	NS	2.928	.01

Table 2

A COMPARISON OF COOPERATIVE ENGLISH TEST

GRADE 10: Fall 1967

MATH A

	Reading Vocab	Reading Level	Reading Speed	Reading Total	English Expression
Modern Mean Group 1	40.26	20.77	34.13	74.39	50.23
Traditional Mean Group 2	35.39	18.39	28.87	64.26	46.50
Transitional Mean Group 3	39.08	20.44	32.79	71.86	50.11
F's	5.897	4.436	5.422	6.527	2.116
Significant	.01	.05	.01	.01	NS
T's and Significance					
1 : 2 =	3.361 .01	2.980 .01	3.205 .01	3.527 .01	2.002 NS
1 : 3 =	1.675 NS	0.852 NS	1.678 NS	1.804 NS	0.134 NS
2 : 3 =	2.614 .01	2.635 .01	2.453 .05	2.720 .01	1.989 NS

Table 3

A COMPARISON OF STANFORD NUMERICAL COMPETENCE AND MATHEMATICS A TESTS

GRADE 10: Fall 1967

MATH A

	Numerical Competence		Mathematics A	
Modern Mean Group 1	29.45		26.20	
Traditional Mean Group 2	29.82		19.68	
Transitional Mean Group 3	31.71		25.93	
F's	7.527		20.731	
Significant	.01		.01	
T's and Significance				
1 : 2 =	0.301	NS	6.285	.01
1 : 3 =	3.782	.01	0.526	NS
2 : 3 =	1.585	NS	6.191	.01

Conclusions

Table 1, 2, and 3 present the analysis of variance for these three groups. It is clear from the results of that analysis that in those tests which measure verbal skills the modern and the transitional groups are very similar and that the traditional group is significantly different from them. There are no significant differences on any of the 7 tests between the modern and the transitional group on verbal measures. On the tests which measure mathematics and quantitative skills the situation is quite different. On the SCAT Quantitative and Numerical Competence tests, there are no significant differences between the traditional and the modern group and there is no significant difference between the transitional and the traditional group. There is a significant difference between the modern and the transitional group, favoring the transitional group. When we come to Mathematics A, however, which is a test which measures knowledge of algebra and geometry, we find the pattern re-establishing itself that was true with the tests which measure verbal ability. There are no significant differences between the modern and the transitional group but there is a very significant difference between either the modern and the traditional group or the transitional and the traditional group, in both cases, favoring the modern or the transitional group.

The results of this analysis would seem to indicate the following is true about computation ability: if the textbook used in the school classroom is classified as either traditional or transitional, the students learn approximately the same amount that students in a traditional textbook learn but they do not learn as much as students in a transitional textbook do.

When, however, we look at the subject of algebra or geometry, it becomes very apparent that students studying with either the aid of a modern text or a transitional text apparently perform markedly better than students who study only with a traditional text.

Tables 4 - 6 and percentile charts I - X give us some additional information about these three groups. These tables and charts confirm what we have already said as the result of the analysis of variance, namely that we are dealing with two separate populations here as measured by the testing of verbal skills. The modern and transitional group seem to make up one group and the traditional group seems to be a rather separate entity. The tables and charts seem to clearly indicate that the modern and transitional group perform markedly superior to the traditional group at all levels on tests which measure verbal skills.

The separateness of these populations changes when we talk about quantitative skills or computational skills. Here the transitional group stands by itself while the modern and the traditional group stand together. On the Computation subtest the charts and tables clearly indicate that at all levels the transitional group is performing markedly superior to the modern and traditional group.

On the Stanford High School Mathematics Test, Part A, the table and graph clearly indicate that the traditional group, at all selected percentiles, is performing markedly poorer than the other groups, transitional and modern. The raw score differences found at these selected percentiles in this table and chart can not, in the author's opinion, be attributed solely to the community or genetic factors or environmental factors with which these children come to school. It seems clear to him that the great difference is also markedly the result of the instruction, i.e. the textbook, and that the students who were taught using either a transitional or modern textbook had a marked advantage when it came to the subject of algebra and geometry, over those students who had studied from a traditional text.

Table 4

A COMPARISON OF SELECTED PERCENTILES FOR SCHOOL AND COLLEGE ABILITY TEST

GRADE 10: Fall 1967

MATH A

NAME OF TEST	SELECTED PERCENTILES IN RAW SCORES				
	10th	25th	50th	75th	90th
SCAT Verbal					
Modern Group	21	29	37	45	50
Traditional Group	19	23	28	38	44
Transitional Group	22	28	36	44	50
SCAT Quantitative					
Modern Group	22	27	32	36	40
Traditional Group	25	28	32	36	40
Transitional Group	24	29	34	38	42
SCAT Total					
Modern Group	45	59	69	79	87
Traditional Group	44	54	62	71	81
Transitional Group	49	59	70	80	89

Table 5

A COMPARISON OF SELECTED PERCENTILES FOR COOPERATIVE ENGLISH TEST

GRADE 10: Fall 1967

MATH A

NAME OF TEST	SELECTED PERCENTILES IN RAW SCORES				
	10th	25th	50th	75th	90th
Reading Vocabulary					
Modern Group	29	34	40	45	51
Traditional Group	25	30	35	39	44
Transitional Group	27	33	39	45	50
Reading Level					
Modern Group	14	17	21	24	26
Traditional Group	12	15	18	21	24
Transitional Group	14	17	20	23	25
Reading Speed					
Modern Group	20	28	34	40	46
Traditional Group	18	22	28	33	40
Transitional Group	20	25	33	39	45
Reading Total					
Modern Group	51	64	75	85	95
Traditional Group	45	54	64	71	82
Transitional Group	49	59	72	84	94
English Expression					
Modern Group	36	42	50	57	64
Traditional Group	35	41	45	53	57
Transitional Group	37	43	49	57	64

Table 6

A COMPARISON OF SELECTED PERCENTILES FOR STANFORD NUMERICAL COMPETENCE AND MATHEMATICS A TESTS

GRADE 10: Fall 1967

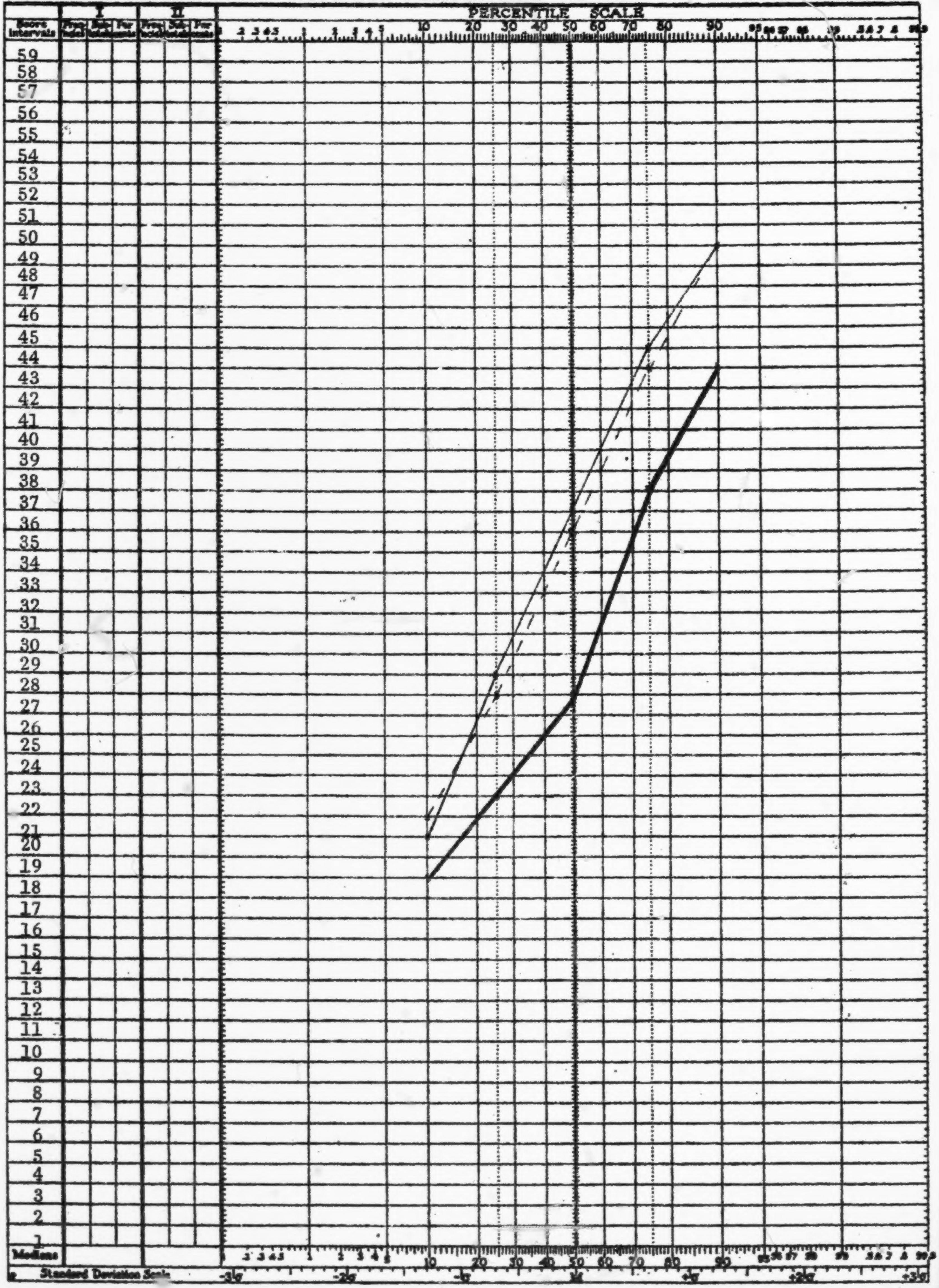
MATH A

NAME OF TEST	SELECTED PERCENTILES IN RAW SCORES				
	10th	25th	50th	75th	90th
Numerical Competence					
Modern Group	19	24	29	34	38
Traditional Group	21	24	29	34	38
Transitional Group	22	27	32	36	40
Mathematics A					
Modern Group	17	21	26	30	34
Traditional Group	13	14	19	23	27
Transitional Group	19	22	26	29	33

SCAT VERBAL MATH A GRADE 10 Chart I FALL '67

NORMAL PERCENTILE CHART

By Arthur S. Otis

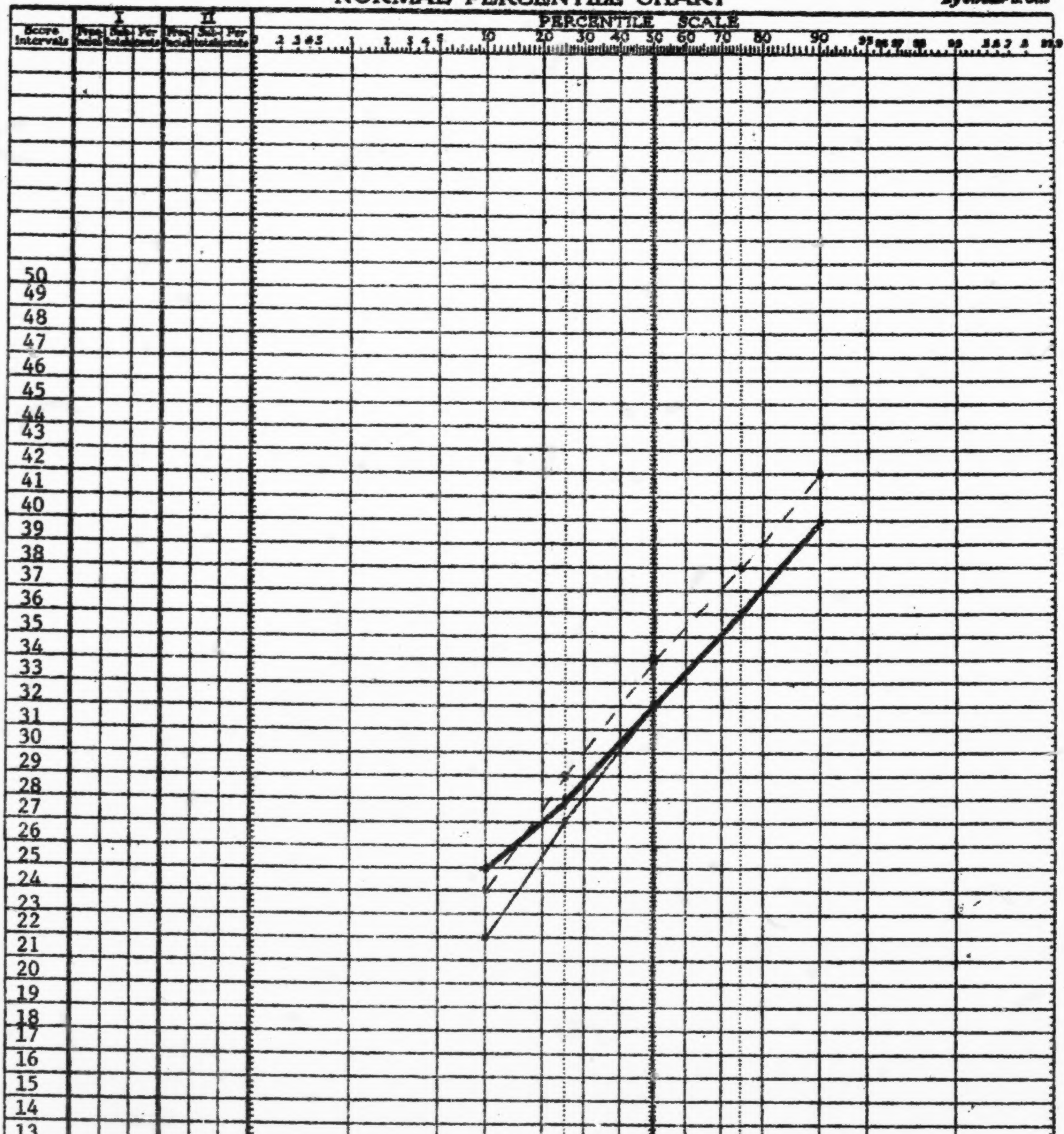


---- TRAN., ▬ TRAD., ___ MODERN

SCAT QUANTITATIVE MATH A GRADE 10 Chart II FALL '67

NORMAL PERCENTILE CHART

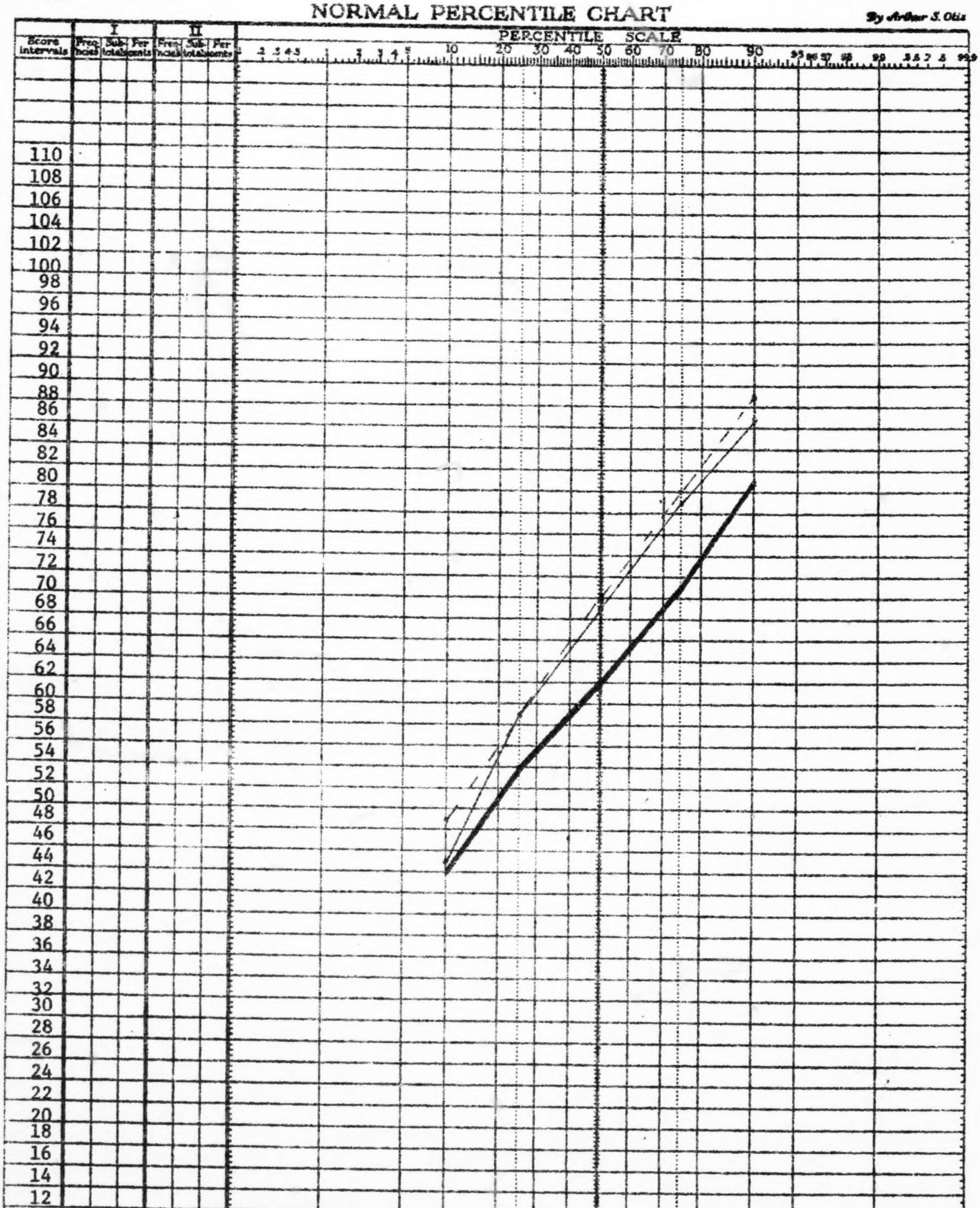
By Arthur S. Otis



SCAT TOTAL MATH A STUDY GRADE 10 Chart III FALL '67

NORMAL PERCENTILE CHART

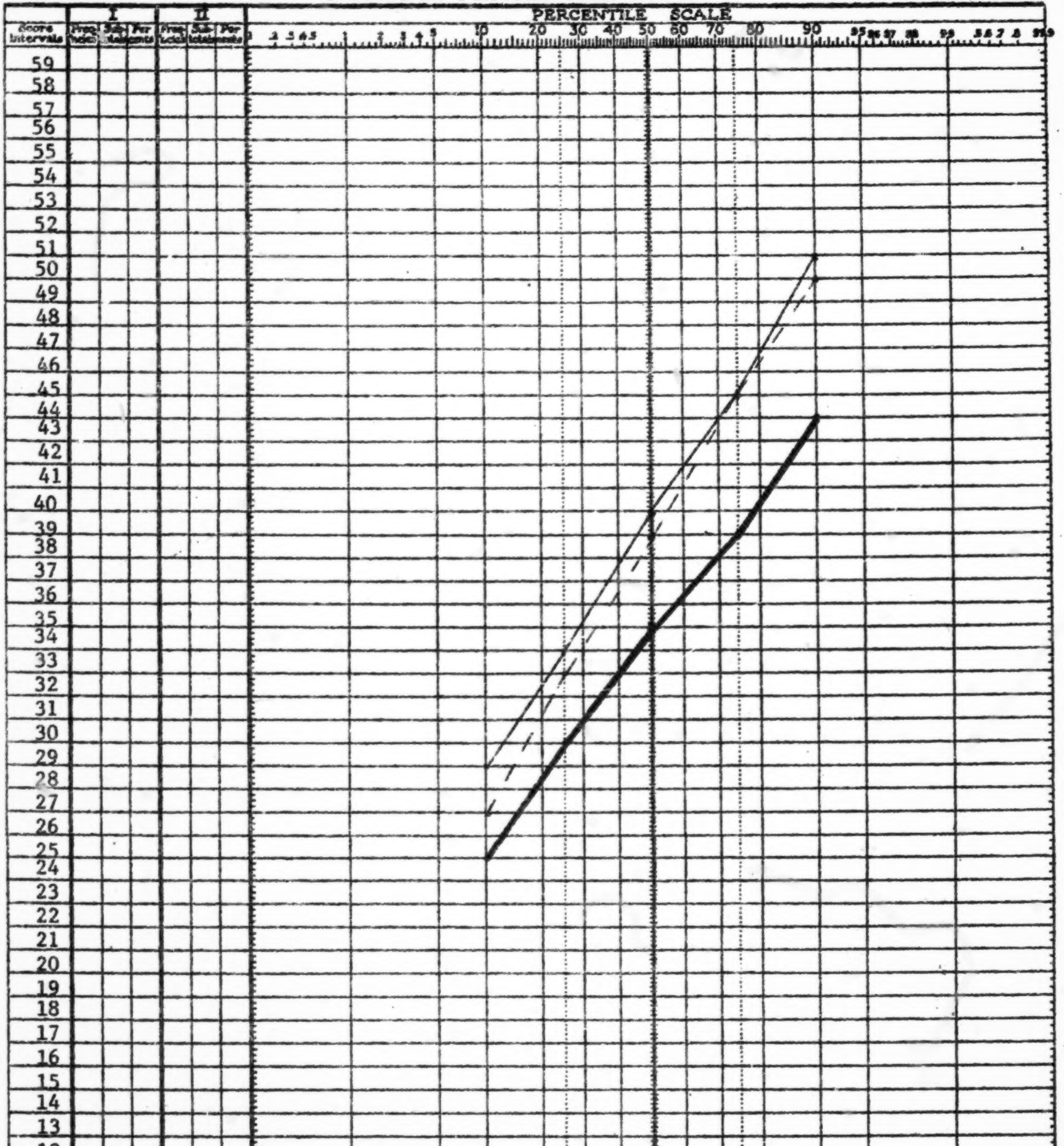
By Arthur S. Otis



READING VOCABULARY MATH A GRADE 10 Chart IV FALL '67

NORMAL PERCENTILE CHART

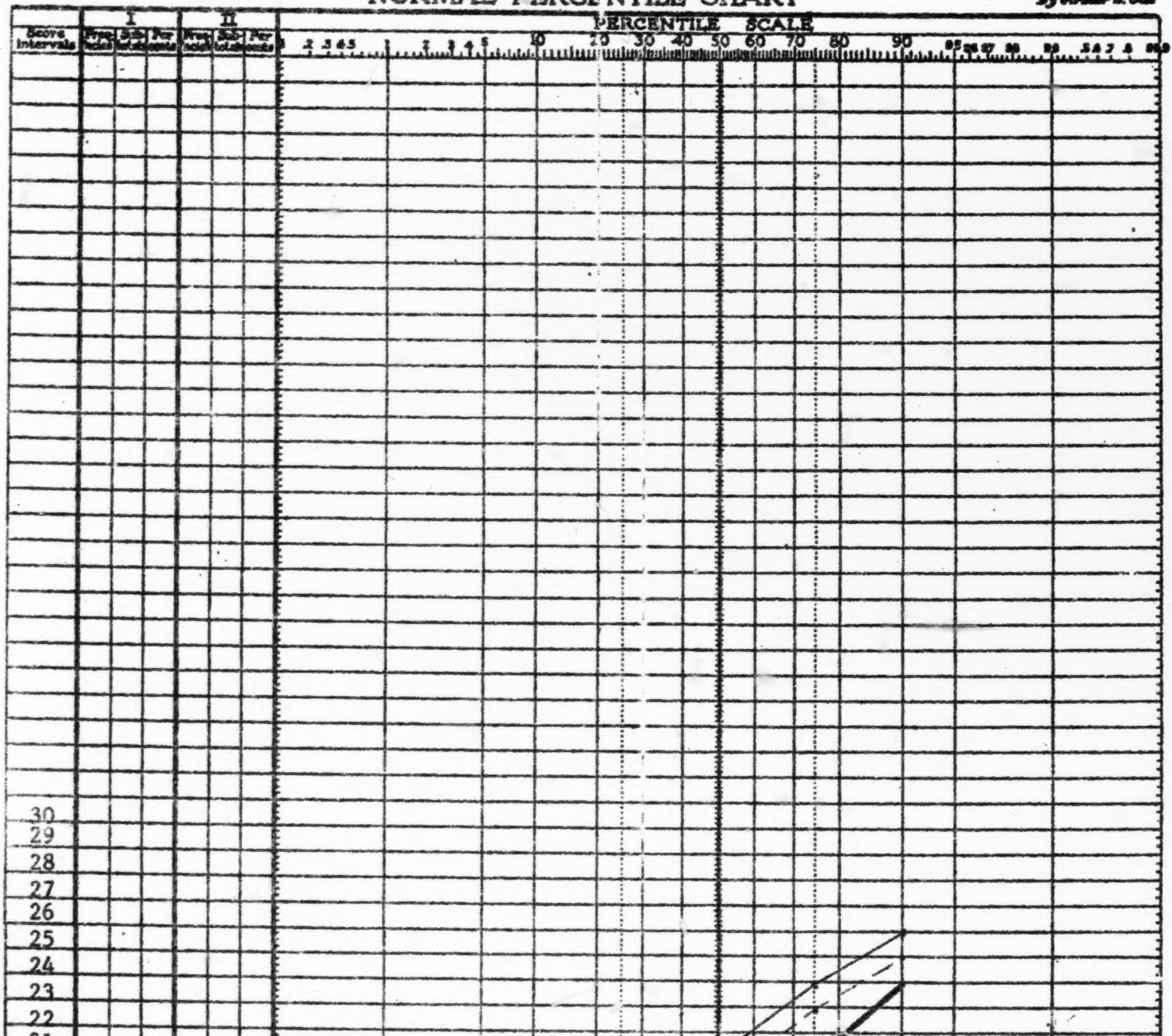
By Arthur S. Otis



READING LEVEL, MATH A GRADE 10 Chart V FALL '67

NORMAL PERCENTILE CHART

By Arthur S. Otis

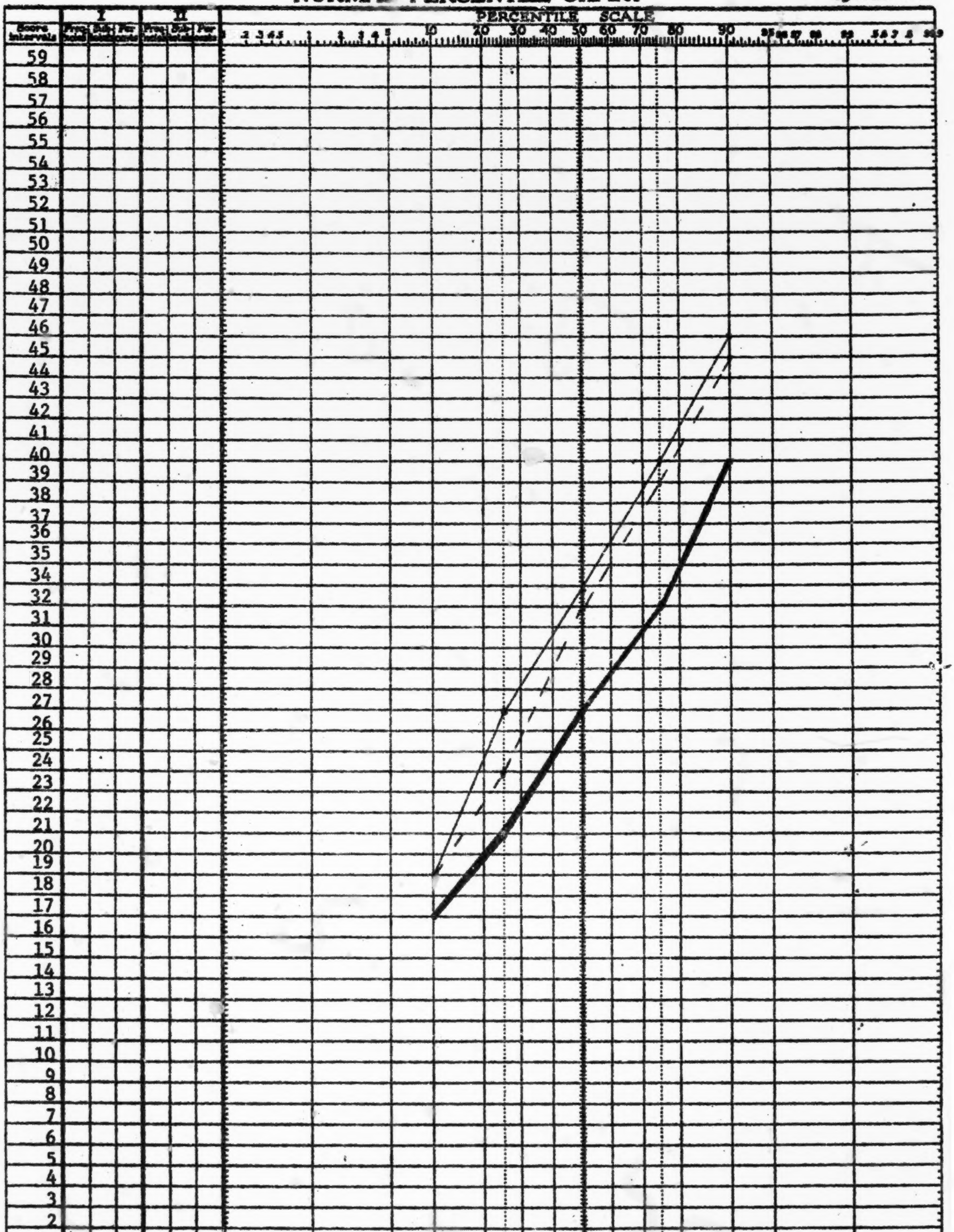


READING SPEED

MATH A STUDY GRADE 10 Chart VI FALL '67

NORMAL PERCENTILE CHART

By Arthur S. Otis



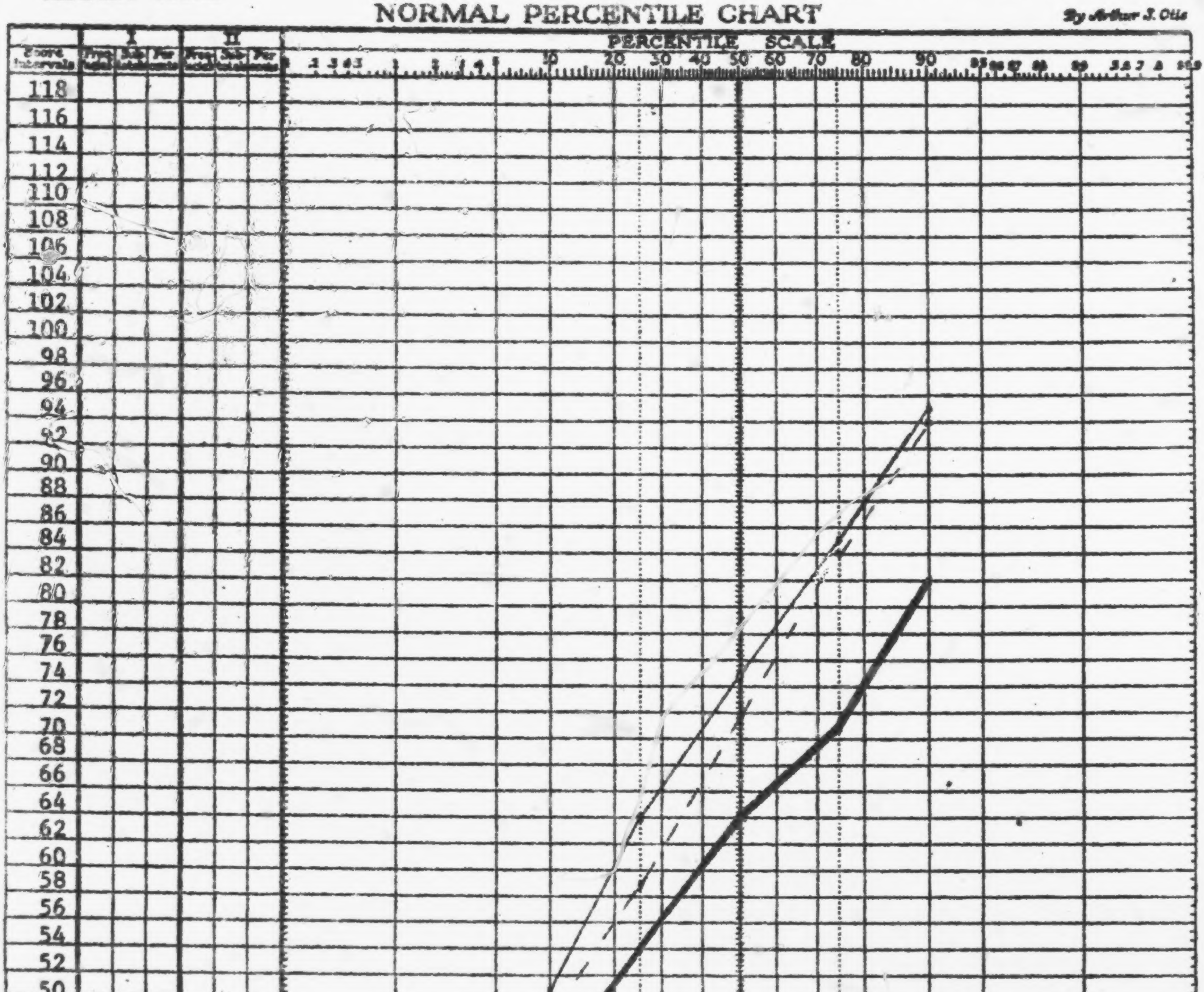
-- TRAN., ▬ TRAD., ___ MODERN

READING TOTAL

MATH A STUDY GRADE 10 Chart VI FALL '67

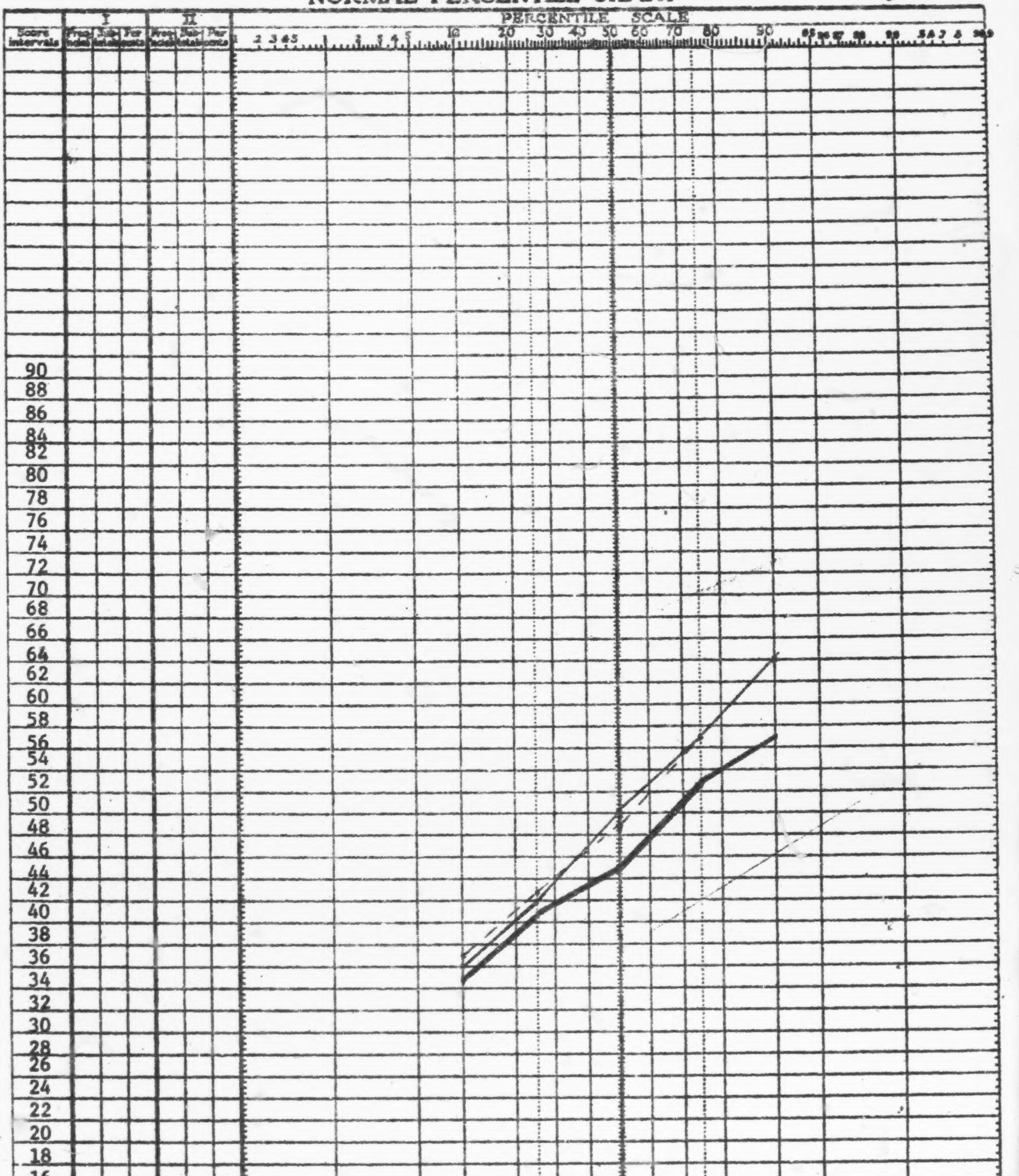
NORMAL PERCENTILE CHART

By Arthur S. Otis



NORMAL PERCENTILE CHART

By Arthur S. Otis



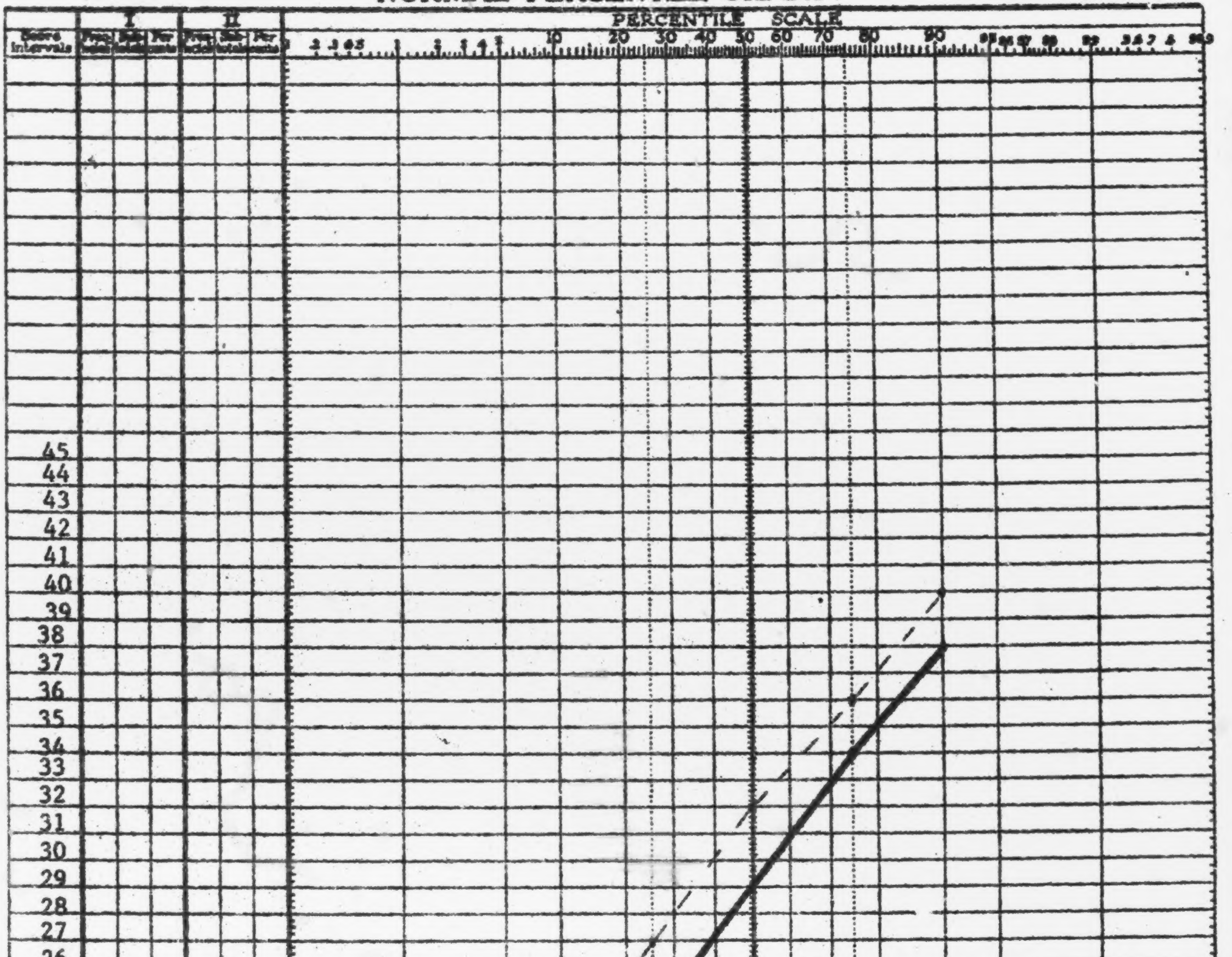
---TRAN., ▬TRAD., ___MODERN

NUMERICAL COMP.

MATH STUDY A GRADE 10 Chart IX FALL '67

NORMAL PERCENTILE CHART

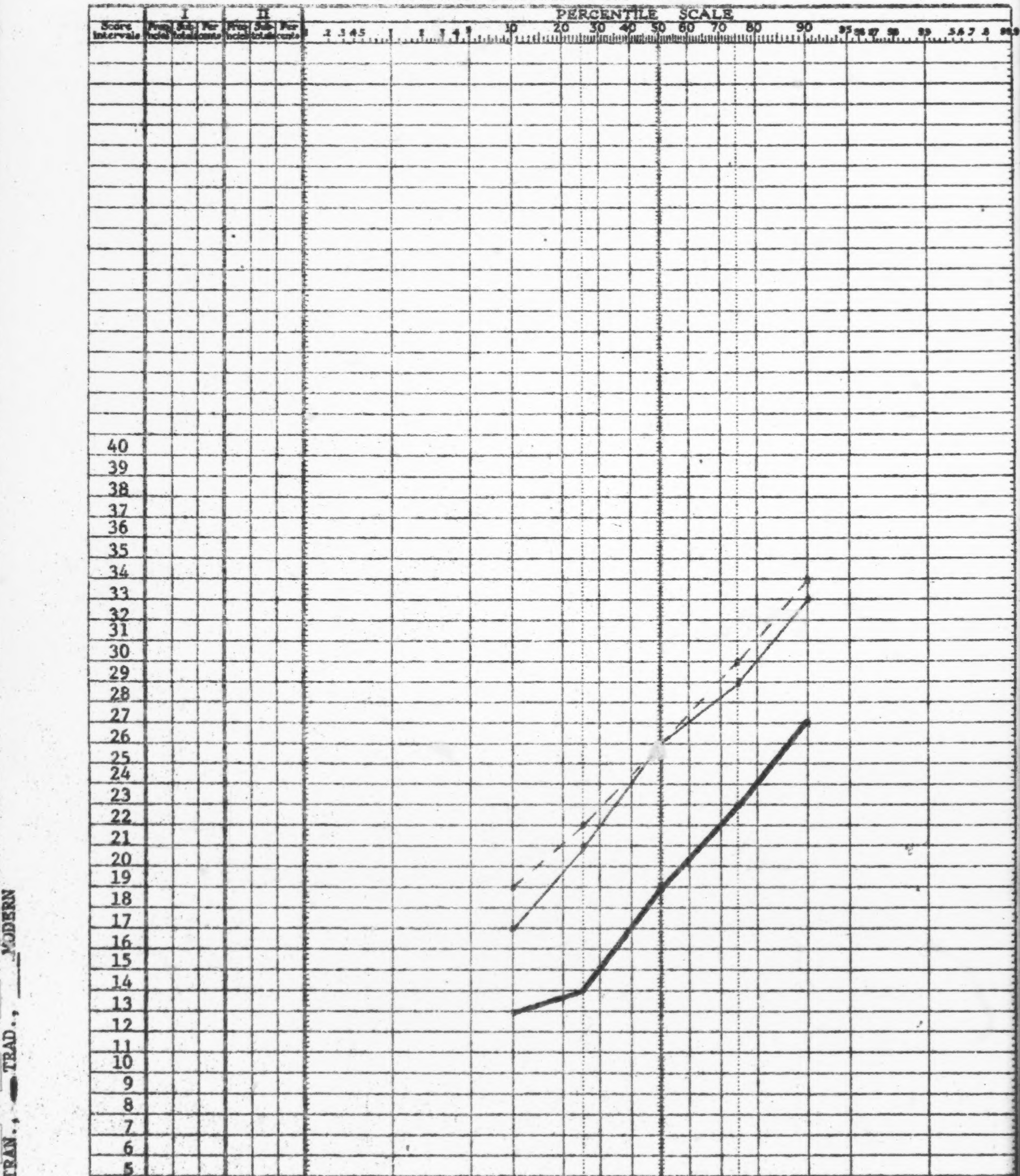
By Arthur S. Otis



TRAN. TRAD. MODERN

MATH A MATH A STUDY GRADE 10 Chart X FALL '67

NORMAL PERCENTILE CHART



APPENDIX

References

BOOKS

Ferguson, George A. Statistical Analysis in Psychology and Education. New York: McGraw-Hill, 1959.

REPORTS

Austin, Gilbert R. (ed.). *New Hampshire Eighth Grade Testing Program*. Report for school year 1967-1968, sponsored by the New Hampshire State Department of Education in cooperation with the Bureau of Educational Research and Testing Services. University of New Hampshire, 1967.

-----. (ed.). *New Hampshire Eighth Grade Testing Program*. Report for school year 1966-1967, sponsored by the New Hampshire State Department of Education in cooperation with the Bureau of Educational Research and Testing Services. University of New Hampshire, Fall, 1966.

-----. (ed.). *New Hampshire Eighth Grade Testing Program*. Report for school year 1965-1966, sponsored by the New Hampshire State Department of Education in cooperation with the Bureau of Educational Research and Testing Services. University of New Hampshire, November, 1965.

Durost, Walter N. (ed.). *Report and Summary*. *New Hampshire Statewide Grade Eight Testing Program*. Report prepared by the Test Service and Advisement Center, Concord, New Hampshire, November, 1964.

-----. (ed.). *Report and Summary*. *New Hampshire Statewide Grade Eight Testing Program*. Report prepared by the Test Service and Advisement Center, Concord, New Hampshire, November, 1963.

Dyer, Henry S., Linn, Robert L., and Patton, Michael J. *Methods of Measuring School System Performance*. Report to the New York State Education Department. Prepared by Educational Testing Service, Princeton, New Jersey, August, 1968.

Hogan, Thomas P. *Some Notes on the Performance of Pupils in Modern and Traditional Mathematics Programs on Standardized Arithmetic Tests*. Report prepared by Test Department, Harcourt, Brace and World.

References

OTHER SOURCES

Cooperative School and College Ability Tests. Princeton: Educational Testing Service, 1956-57.

Derrick, Clarence, Harris, David P. and Walker, Biron. Cooperative English Tests. Princeton: Educational Testing Service, 1960.

Durost, Walter N. (General Editor). Metropolitan Achievement Tests. High School Battery. New York: Harcourt, Brace and World, 1962.

Gardner, Eric F. et al. Stanford Achievement Test. New York: Harcourt, Brace and World, 1964.

-----. Stanford High School Mathematics Test. New York: Harcourt, Brace and World, 1964.

-----. Stanford High School Numerical Competence Test. New York: Harcourt, Brace and World, 1964.

Kelley, Truman L. et al. Stanford Achievement Test. Technical Supplement. New York: Harcourt, Brace and World, 1966.

Otis, Arthur. Otis Quick-Scoring Mental Ability Tests. New York: Harcourt, Brace and World, 1954.